ESD-TDR-62-350

PHASE I OF INVESTIGATION OF THE EFFECTS OF ENVIRONMENT ON THE REDESIGN OF AN/TSQ-47

TECHNICAL DOCUMENTARY REPORT NO. ESD-TDR-62-350

7 FEBRUARY 1963

482L/431L SYSTEMS PROGRAM OFFICE
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
L. G. Hanscom Field, Bedford, Mass

(Prepared under Contract No. AF19(628)-1635 by Operations and Systems Analysis, North American Aviation, Inc., Los Angeles Division, Los Angeles 9, California)

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FOREWORD

This Technical Documentary Report covers work conducted under Phase I of Electronic Systems Division Contract AF19(628)-1635, "Investigation of Effects of Environment on Redesign of AN/TSQ-47" Technical Support Division, for the 482L/431L SPO, ESD.

The analyses were performed by the Military Operations Group of Operations and Systems Analysis, North American Aviation, Inc. with support from the Climatic Center, USAF.

ABSTRACT

This report covers the initial phase of a study of environmental effects on redesign of the AN/TSQ-47, Air Traffic Control/Communications System. The areas of expected deployment of the AN/TSQ-47 were derived from historical conflict data; airbases throughout the world at which the system may operate were compiled, and climatic data for selected locations were chosen to represent conditions which may be encountered by the system. This report presents a summarization of data on more than 10,000 bases with a cursory analysis of probable deployment.

This document has been reviewed and approved.

B. F. GREENE, JR.
Chief, Technical Support Division
4821/431L System Program Office
Deputy for Systems Management

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INTRODUCTION AND SUMMARY

The purpose of this study is to investigate that redesign of the AN/TSQ-47 Air Traffic Control/Communications System necessary to better adapt it to the environmental factors likely to be encountered during the period 1963 to 1968. This includes consideration of airport conditions and configurations, extent and type of existing navigational and air traffic control facilities, frequency of occurrence of multi-terminal areas, climatic conditions, and terrain features of these areas.

"The AN/TSQ-47 is an air-transportable/mobile system, designed to provide the highest possible air traffic control, landing, navigation, and communications capability considering equipments currently available, and the stringent deployment and environmental requirements imposed by Specific Operational Requirement (SOR) 194. The system will be deployed and operated by AFCS Mobile Squadrons in support of air operations in situations where fixed facilities are not available."

Phase I of the study, reported herein, involved collection and cursory analysis of environmental data. A trip was made to the major using commands early in the study to obtain information on probable areas of deployment. In the opinion of the operating commands, AN/TSQ-47 must be deployable to all parts of the world. This information was considered in the light of incidence of armed conflict and use of U.S. troops since World War II to derive probable areas of future armed conflicts and deployment possibilities. These possible uses of the AN/TSQ-47 together with peacetime applications were synthesized to determine the probability of the systems being deployed to various areas of the world.

Information has been collected on the location and facilities of present airbases throughout the world and outside of the Communist bloc. The subjects considered of most interest for Emergency Mission Support (EMS) use are location, runway data, facilities information, and accessibility for military use. Data for the U.S. are complete in this phase of the study. Foreign data will be augmented in Phase II.

Climatic data, especially extreme conditions, were gathered for all significant areas of the world. Basic climate data was provided by the Climatic Center, USAF, for this study. Extensive weather data is not presented in this report as its use without correlation with other phases of the study may yield misleading results.

The data analyzed to date indicate that:

(1) Airbases suitable for modern military aircraft exist in every major climatic region of the world.

(2) The AN/TSQ-47 design specifications can be based on environments encountered at existing airdromes without compromising their validity.

(3) Many of the extreme environments may be avoided by operational planning.

During phase II of this study the basic data presented in this report will be augmented and the environmental data will be analyzed in relation to AN/TSQ-47 design requirements. The objective of Phase II will be the determination of specific AN/TSQ-47 redesign recommendations on the basis of probable operational environments.

SECTION I

DEPLOYMENT

DEPLOYMENT AREAS

The first step in determining the probability of encountering a given environment is to determine the areas in which the AN/TSQ-47 is expected to be employed. The system is to be deployable to any part of the world in which it is needed to support military or civilian aircraft. There are, however, higher probabilities of deployment to some regions than to others.

Comprehensive information was not obtainable from the using commands. Therefore, historical events have been investigated to predict future use of AN/TSQ-47. The peacetime uses were predicted on the assumption that past deployments are representative of future requirements. Wartime uses were estimated by predicting potential areas of conflict in the 1962 to 1968 time period.

PEACETIME DEPLOYMENT

The range of peacetime uses is summarized in Table I. A complete list would show heavy use on training missions to tropical Carribean and subtropical regions of Southeastern U.S. as well as base construction effort in arctic regions of Canada and Greenland.

WARTIME DEPLOYMENT

An historical approach was used to predict trouble areas. Figure 1 to 3 illustrate countries in which an insurrection or was has occurred since 1946. The nature of these outbreaks and their year of occurrence are given in Reference (a). The expected trouble areas for the near future (next six years) are shown in Figure 4. These conflicts are expected to be of a nature that aircraft may be used to advantage. Figure 5 shows the countries with which the U.S. has a treaty, relationship, or vested interest that would permit or require it to take an active part. As indicated by Figure 4, there are four major areas where outbreaks of conflict can be expected --- Southeast Asia, Africa, Latin America, and the Near East.

Conflict Factors -- An exploratory study is being conducted by North American Aviation, Inc. (NAA) to determine if factors can be isolated and evaluated which would give a reliable indication of conflict potential within a country. The following section draws heavily on the unpublished work. The entire study is of an experimental nature and the criterion by which unrest is measured has not yet been verified. The relevant factors considered were precedence of earlier political activities, the size of the army relative to the number of people in the country, the distribution of wealth, the distribution of income, levels of unemployment, distribution of land ownership, and degree of communist activity.

Political action within a given national or regional system will tend to conform to a pattern appropriate to the political framework and history. Consequently, those countries which have used constitutional means recently and often in the past are more inclined to use them in the future. Those which have a history of violent action can be expected to resort to violence in the future.

The size of the army is some indication of the degree of responsiveness of the national leadership. With a small army the government is more responsive to pressure from outside groups. Distribution of wealth, income, and land are generally related to political power. If the wealth of the nation is consolidated in the hands of a minority, the direction of government policy is likely to be responsive to this small group. An educated middle class provides the nucleus for movements of change within a country. A large lower class provides potential followers for an agitating group, especially if unemployment is high.

Communist activity is an important factor and one which is difficult to evaluate. The purpose of communist activities is to organize the dissident groups into concerted action against the established government. The existence of a strong communist movement is an indication that other criteria for a stable economy and government are not being met.

In order to determine a means for measuring the conflict potential within a country, a record was made of all major activities which had political significance, including governmental administrative changes (both legal, such as elections, and illegal, such as revolution and coups-de-tat). Large civil disturbances such as riots, strikes and demonstrations were also recorded when available. Plus values were assigned to indicate stabilizing influences, and minus values were assigned for factors leading to potential conflicts. Events were plotted for the time period from 1939 to 1961 and countries with negative net values or a negative trend during the latter part of the period were given high potentials. These conflict potential values are summarized in Table II.

Regions of Conflict - Conflicts in Asia can be predicted due to the expansionist policies of communist China. The trouble in Africa centers on newly emerging countries and the strife in the Near East results from long-term power struggles. The greatest uncertainty in predicting future conflicts occurs for Latin America.

In most Latin American countries there are very clearly marked levels of wealth and large disparities between the very wealthy and very poor. In addition, the governments fail to provide facilities such as education, public health, roadways, etc. In this study basic assumptions included: (1) Wealth and political power go hand in hand, (2) If the wealth of a nation is held by a small minority then government policy is responsive primarily to this group, and (3) Every powerful group will tend to further its own interest.

In the past, insurrection has been sporadic in Latin America, with no country serving as a focal point for other activities. With Cuba as a center or armed Communism, there is little doubt that a definite trend of subversive activity will manifest itself within the decade whether or not the Castro regime is overthrown. The Carribean Islands of Haiti and the Dominican Republic, Guatemala with its history of Communism in the 50's. Venezuela with its oil resources, and strategic Panama are among the potential targets.

The emerging countries of Africa are ripe territory for Communist intervention. Communists will support, from afar, the tribal animosities that exist. Internal violence or regional warfare may erupt. Because of results in the Congo, Russia, with backing by a majority of the neutralists, will attempt to block further U.N. activity in Africa. Direct U.S. support may be requested.

A definite trend exists in the territorial expansion of Communism through China, Indochina, Thailand, and Burma, a move by Indonesia into Australian New Guinea and Papua, and increased unrest in the Phillipines. The fighting will continue in South Viet Nam at least through 1963. The next major battles will be in Thailand. Because of their neutrality, it is unlikely that Laos and Cambodia will receive military support in time. Their battles will be oriented toward internal power struggles.

Border outbreaks will continue between India and China until Nepal and Bhutan are isolated. Then these countries will be invaded. The AN/TSQ-47 will not be used because of the limited action, lack of aircraft utility and facilities, and time needed to react to countries with which the U.S. has no treaty or strong military interest.

From Reference (b) comes the following description of Communist China's objectives.

> "Indochina: We shall give the maximum assistance to our comrades and friends in Indochina. The experiences we have had in Korea should enrich their knowledge in fighting for liberation. The case of Indochina cannot be compared with that of China. In Indochina, as in Korea, there is serious intervention of the capitalist bloc, while in China there was nothing so direct and vigorous. The experience in Korea tells us that so long as there is foreign intervention, and so long as we have no naval support, military operations alone cannot achieve the objective of liberation."

"Burma, Thailand, Indonesia, and the Malay Peninsula: After the liberation of Indochina, Burma will fall in line as a good foundation has already been laid there. The reactionary ruling clique in Thailand will capitulate and the country will be in the hands of the people. The liberation of Indonesia, which will fall to the Communists camp as a ripe fruit, will complete the circle around the Malay Peninsula."

The Near East will flare occasionally. Struggles will continue between Israeli and Arab, between Moslem rulers, and within individual countries. These conflicts will probably not involve American combat troops, but aircraft supporting equipment, and troops may be used as a threat to contain the fighting.

The old trouble spots of Formosa, Korea, Finland, etc. may also erupt. It is unlikely that EMS equipment will be used since fixed facilities can handle the level of action that will be tolerated without starting a global war.

DEPLOYMENT WEIGHTING

The previous analysis can be extended to a qualitative weighting of countries by probability of use of the AN/TSQ-47. Three basic assumptions are made:

(1) AN/TSQ-47 will continue to be the equipment used in the U.S. for training and temporary replacement.
(2) AN/TSQ-47 will not be used in present communist bloc countries.
(3) The AN/TSQ-47 will be used in support for foreign military operations not involving U.S. combat troops.

These deployment probability weightings are shown in Table II as a function of the type of mission expected to occur.

In addition to the historical trend and the conflict potential, the following criteria are used:

(1) The existence of established bases throughout the country.
(2) Existence of military alliance with the U.S.
(3) Size, general terrain, and location of the country which would preclude air activity.

There is, of course, a possibility of operating in any non-communist country in disaster relief. This use is not included in Table II. No attempt was made to predict natural disasters. The number of occurrences of such disasters is small in respect to other deployments.

LIMITATION OF DEPLOYMENT AREAS

The AN/TSQ-47 must be deployable to any part of the world. In the past twenty years, training, combat, and peacetime missions have been conducted in all regions of the world (arctic, desert, tropics, and mountains). However, these missions have not required aircraft to be based at all points of the globe or EMS to operate in all regions. With their speed and striking range, modern aircraft may be based considerable distances from the area of activity.

While it is recognized that the AN/TSQ-47 can be deployed at areas remote from airfields, this study has limited to the more probable deployments at existing airfields. Because of the wide distribution of runways throughout the world, this limitation will not materially affect the results of the study and is in agreement with operational plans of using commands.

OPERATING COMMAND PLANS

SAC and ADC require established bases for operating high performance aircraft. Their planning personnel, while recognizing a possibility of using emergency bases, intend to operate from bases they presently use. In addition, in wartime operations, SAC aircraft can rely on self-contained navigation and landing aids, and will not require deployment of EMS equipment.

TAC considers their aircraft to be deployable to any area of the world, but are still thinking in terms of 7000-foot-long concrete runways which are required by present combat aircraft. This admittedly, will change with the advent of improved helicopters and V/STOL aircraft.

Uses exist for AN/TSQ-47 remote from airbases. STRICOM's requirements for aircraft will be provided by TAC, but they have an independent need for point-point communication. There activities, though world wide,will be near populated areas and adequate transportation. Such locations are generally the sites of established airports.

RUNWAY DISTRIBUTION

The problem of improvised runways still exists. It may be necessary to employ World War II techniques of grading landing areas as needed. These will be constructed at areas that do not presently have airbases. There are, however, preferred locations for these landing areas. Existing bases include all climatic, runway, and facility conditions to be encountered by such improvised runways.

Peacetime deployments outside of the U.S. are of two types. One is disaster relief. This implies there will be people settled in their environment, and where this condition exists there are runways. The other is to send support to our military outposts, which, at the present time, are in the arctic and tropical regions, but within the environmental limits encountered by established bases.

Communication, navigation, and surveillance equipment may be located on a prominent point, remote from the runway it services. Though extremely local climatic changes exist, their magnitude is limited by such factors as remoting is limited to about 20 n.mi. by system accuracy and the remote area must be sufficiently accessible to position and maintain the equipment.

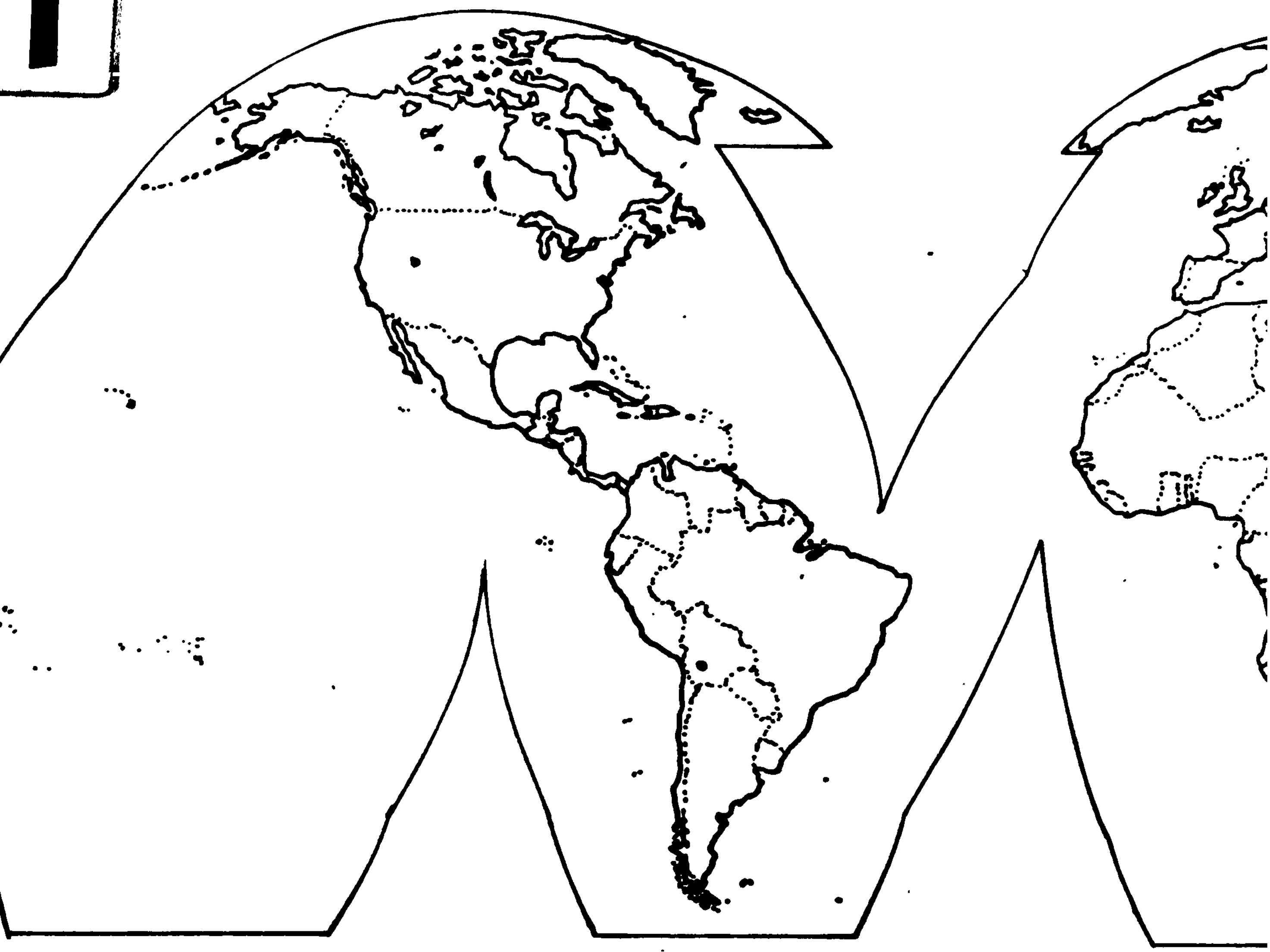
For these reasons, it seems reasonable to study airbase environments as adequately representative of conditions to be encountered by the AN/TSQ-47.

TABLE I

PEACETIME USES OF EMS

EVENT	COUNTRY	CLIMATE
DEW LINE CONSTRUCTION	Greenland & Canada	Subarctic - Arctic
SWIFTSTRIKE	Continental U.S.	humid subtropical
CHILEAN EARTHQUAKE	Santiago, Chile	subtropical
CONGO FAMINE RELIEF	Congo	tropical
HURRICANE RELIEF	Matagordo	tropical
REPLACEMENT OF FACILITIES	Continental U.S.	subtropical - temperate
BANYAN TREE	Panama	tropical
ANTARCTIC EXPLORATION	New Zealand	mediterranean

1



1 Berlin

2 Greece

3 Israel

4 China

5 Phillipines

6 Malaya

2

ARMED CONFLICTS

1945-1949

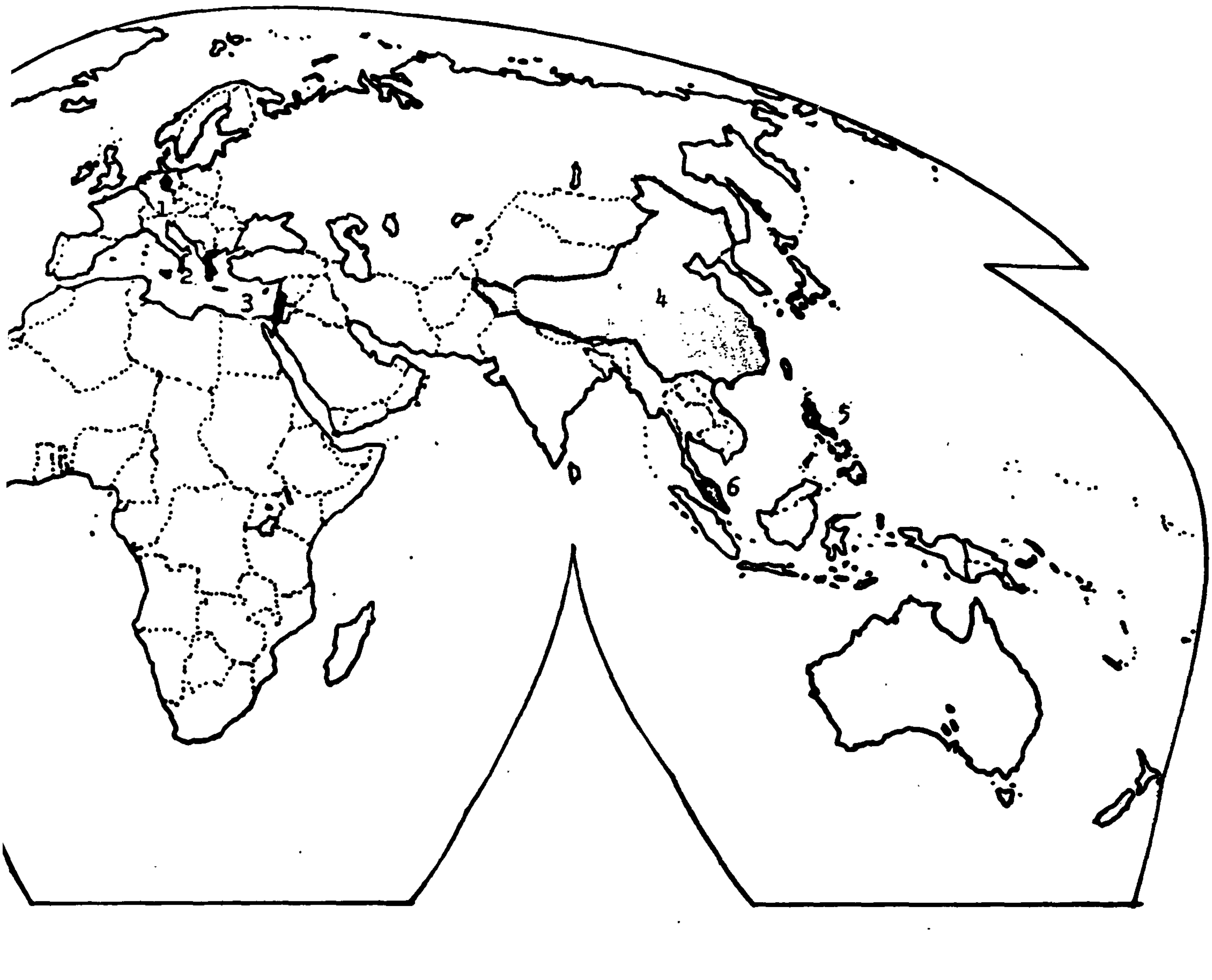
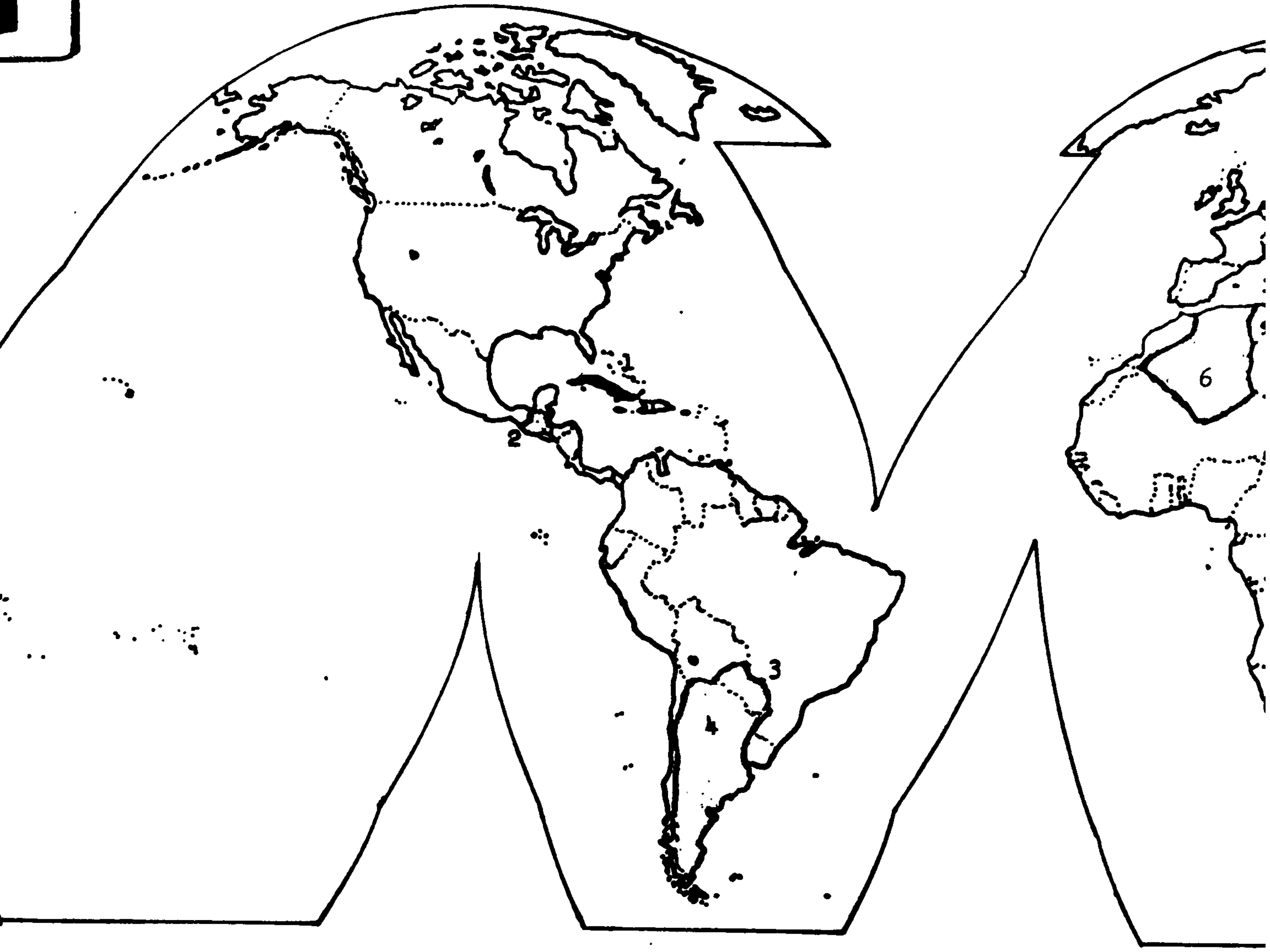


FIGURE 1

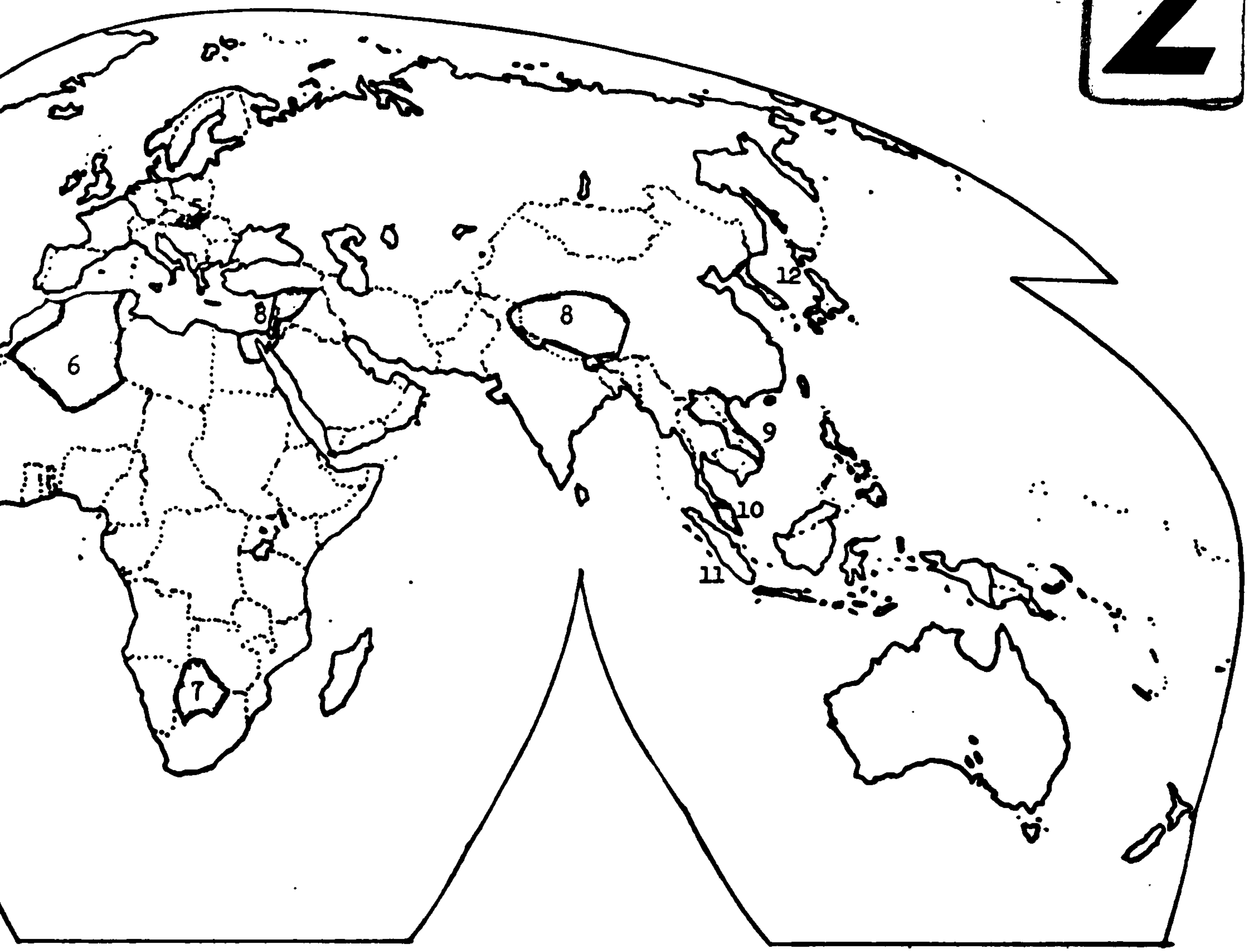


1 Cuba
2 Guatemala
3 Paraguay
4 Argentina
5 Hungary
6 Algeria
7
8
9

ARMED CONFLICTS

1950 - 1959

2



7 Syria - Israel - Suez

8 Tibet & Indian Border

9 Indochina

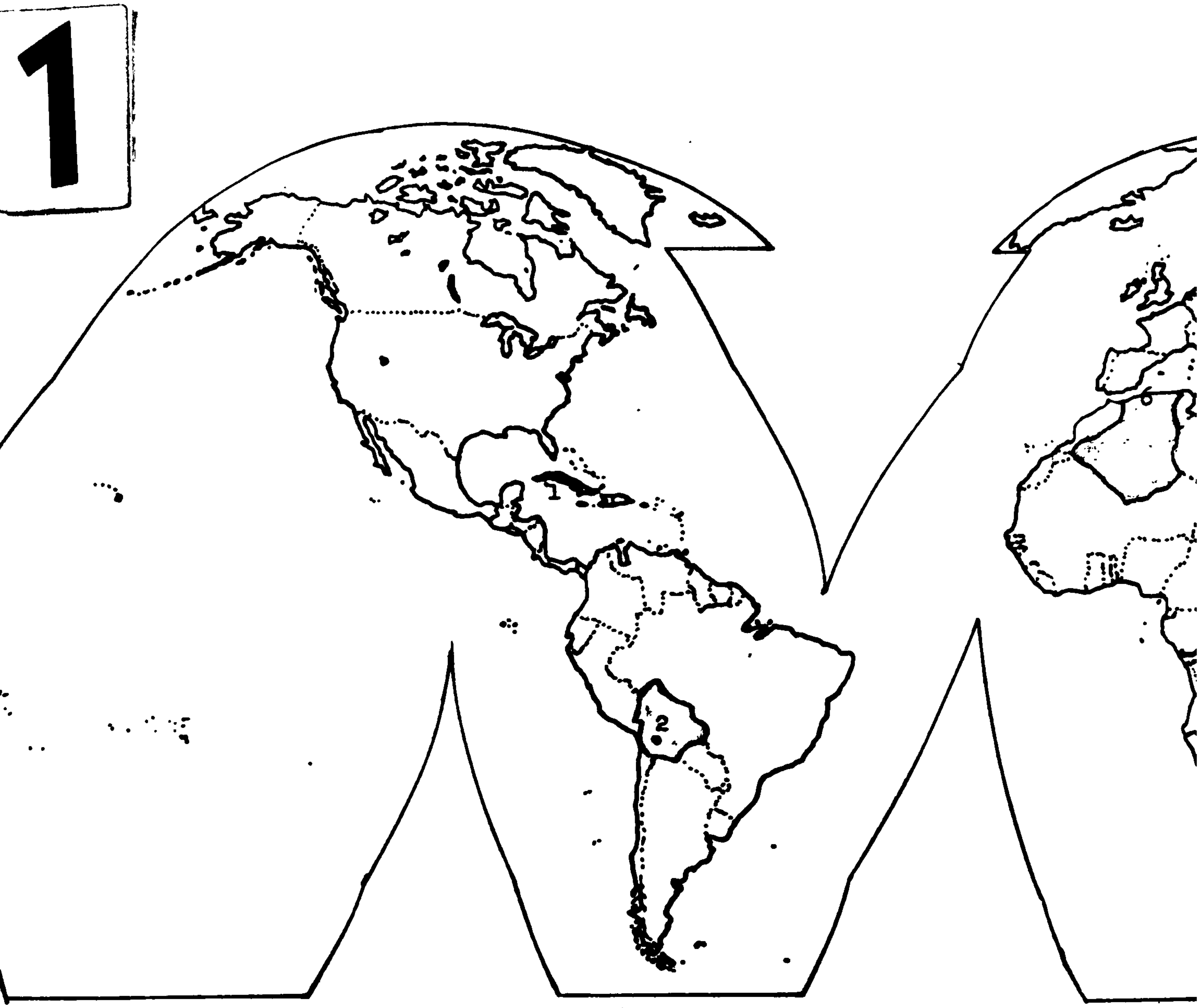
10 Malaya

11 Indonisia

12 Korea

13 Bechuanaland

FIGURE 2



1 Cuba

2 Bolivia

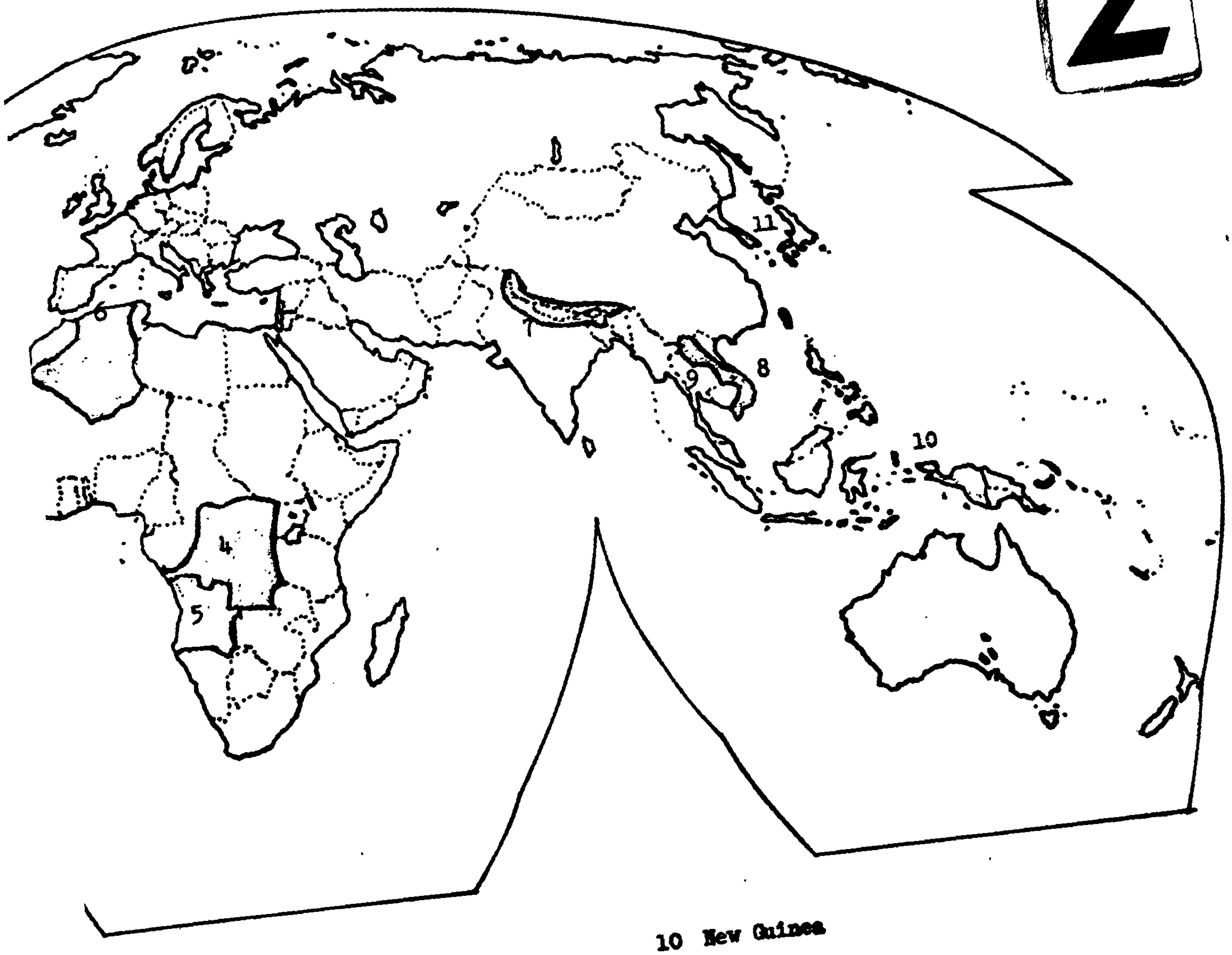
4 Congo

5 Angola

6 Algeria

ARMED CONFLICTS

1960 - 1962



7 India

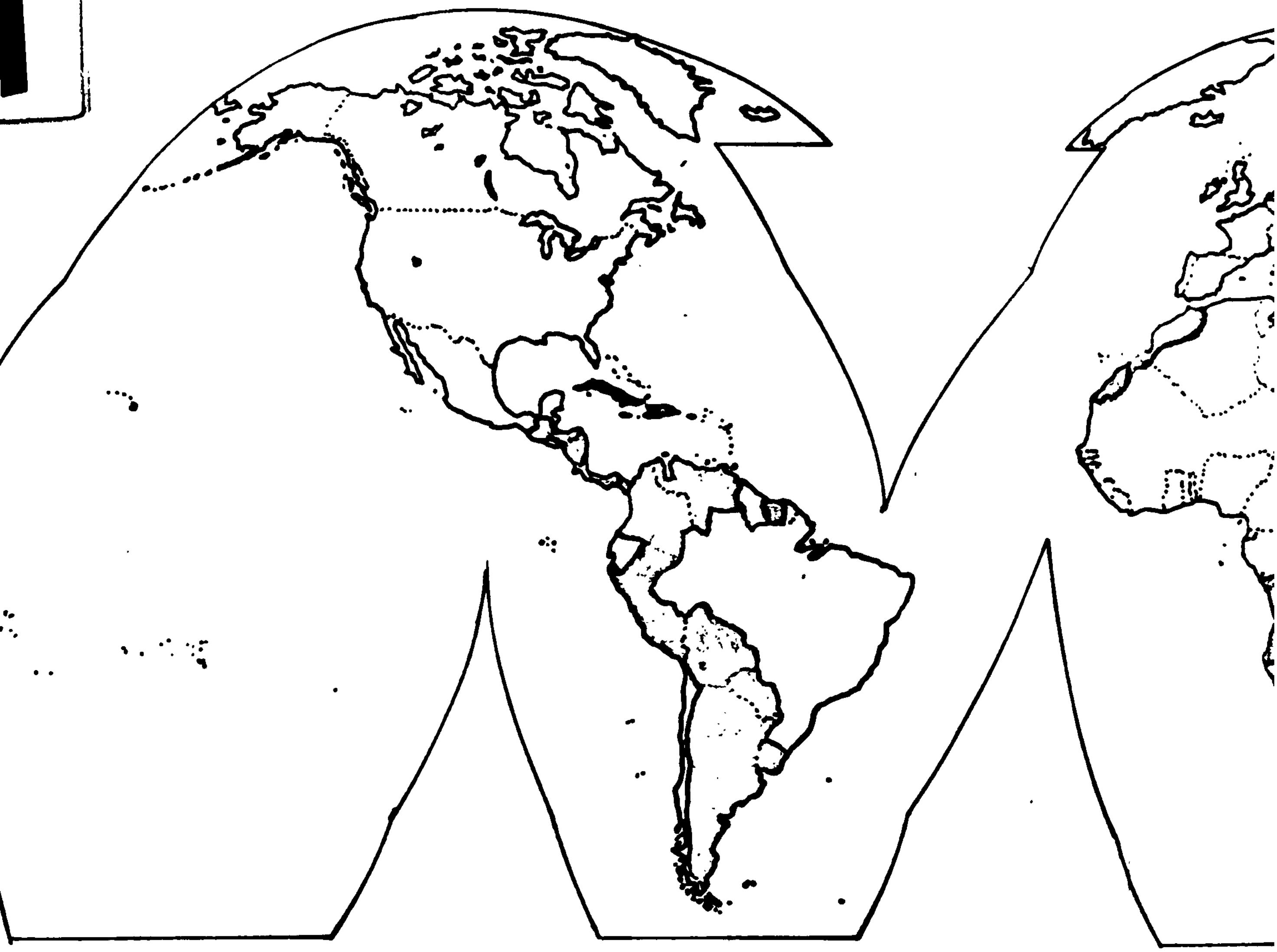
8 Viet Nam

9 Laos

10 New Guinea

11 Korea

FIGURE 3



Conflict Proneness

El Salvador
Nicaragua
Haiti
Bolivia
Venezuela
Argentina
Guatemala

Honduras
Paraguay
Dominican Rep

Cuba
Columbia

Communist Pressure

Costa Rica
Panama

Peru
Surinam

Finland
Morocco

Southern Russian Border
Syria
Korea
Phillipines
Republic of Congo

Indian Expansion

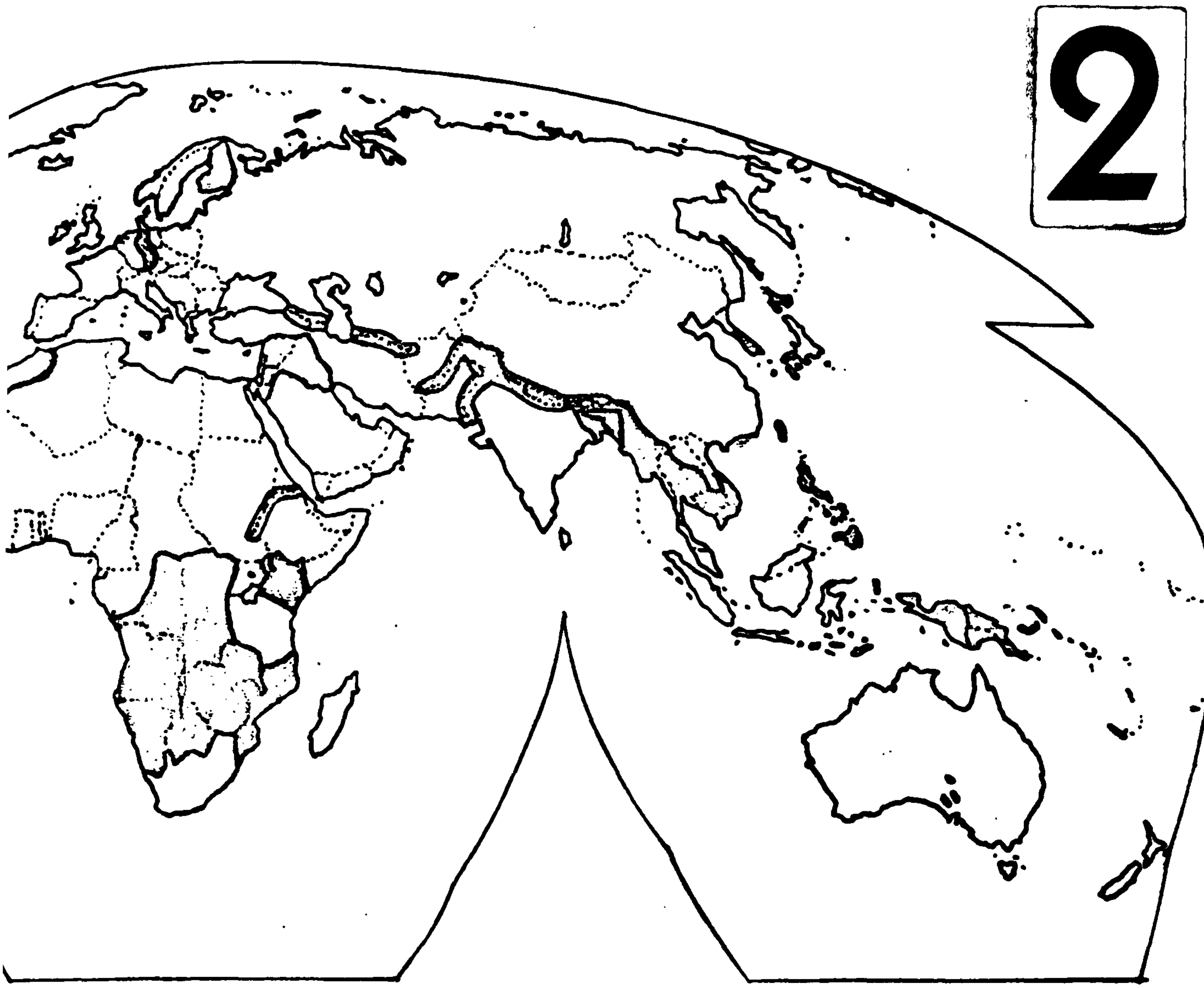
Pakistan
Kashmir

Independence Moveme

Spanish Sahara
Angola
Mozambique

EXPECTED CONFLICTS

1963 - 1968



ansion

nce Movement

ahara

e

South-West Africa
Bechuanaland
Rhodesia and Nyasaland
Kenya

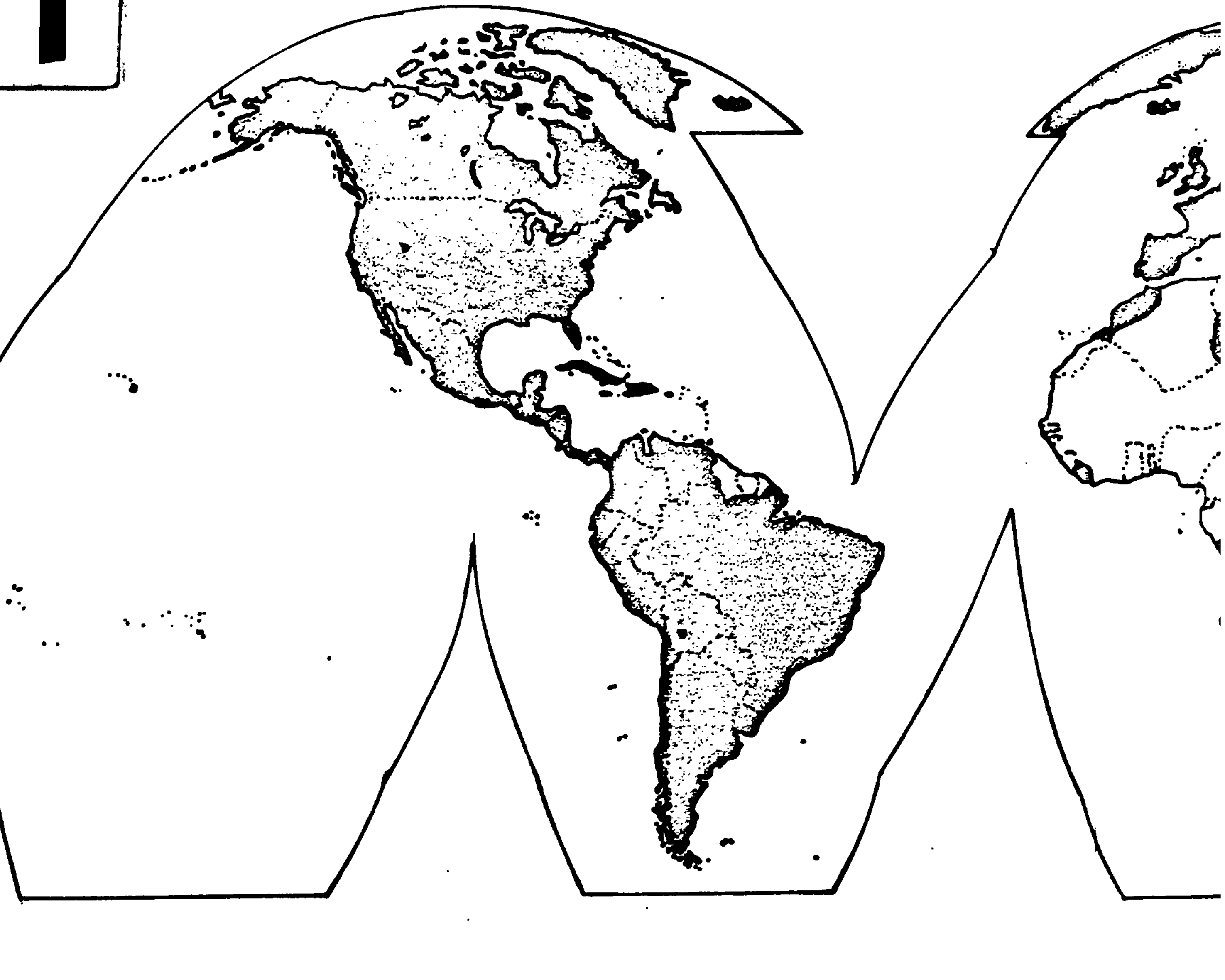
Chinese Expansion
Viet Nam
Cambodia
Thailand

Chinese Expansion
Burma
India

Indonesian Expansion
New Guinea
Papua
Phillipines

FIGURE 4

1



U. S. MILITARY

ALLIANCES AND COMMITMENTS

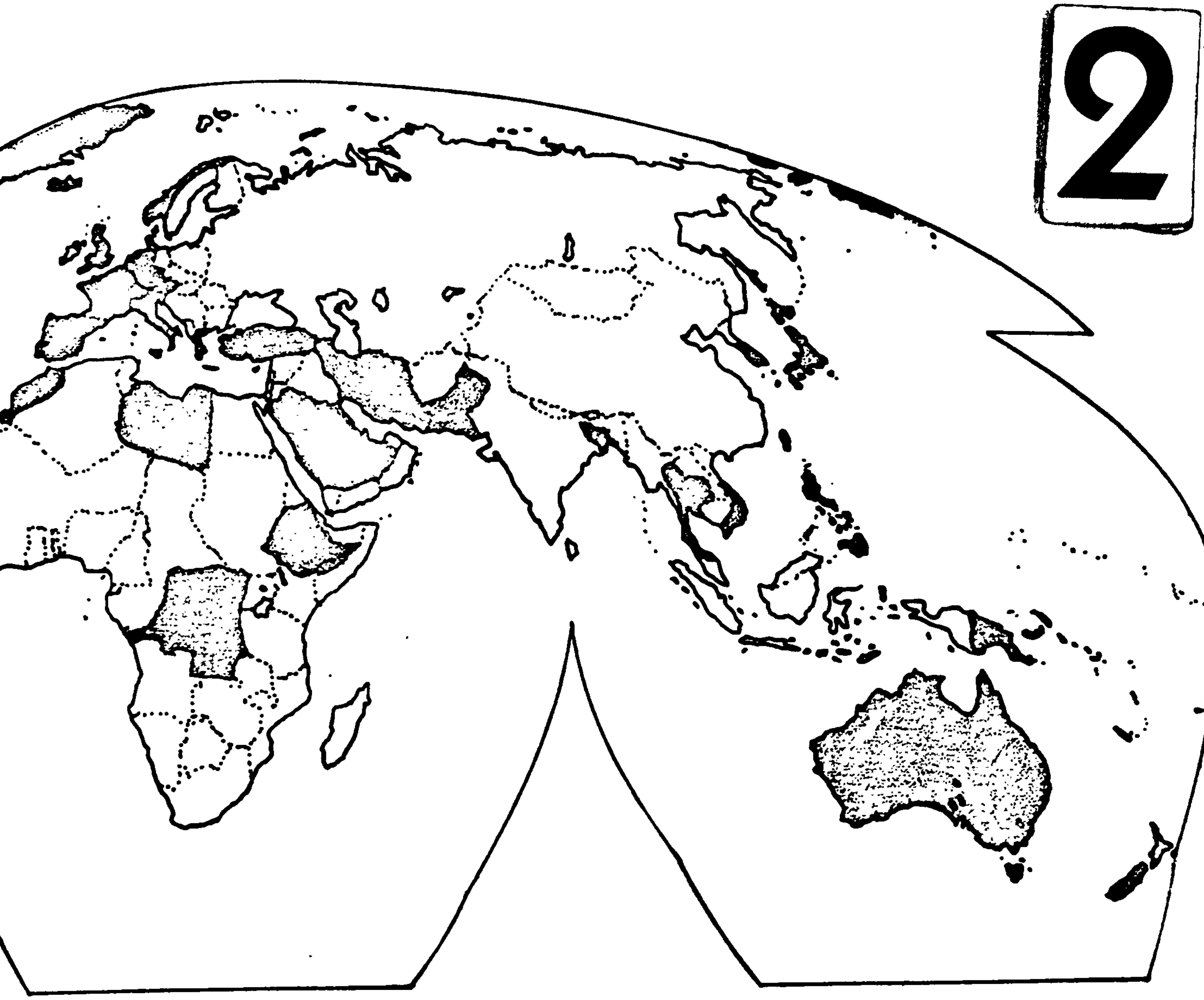


FIGURE 5

COUNTRY	U.S.Z.I.	PANAMA	GERMANY	PHILLIPINES	CANADA	ALASKA	GREENLAND	VIETNAM	KOREA	TAIWAN	NEW GUINEA	JAPAN	THAILAND	GREAT BRITAIN	GUATEMALA	TURKEY	JORDAN	
CONFLICT POTENTIAL	X	-3	X	X	X	X	X	X	X	X	X	X	X	X	-3	X	X	X
TRAINING	C	C	C	C									H	H		M		M
MILITARY CONSTRUCTION	H				C	C	C			M	M	M	L	L	L	L		L
NON-MILITARY	C			M		H						L						L
INVASION		L						C	L	L	H		H					
SHOW OF STRENGTH				M					L		M		H		H	H	H	H
ARMED INSURRECTION				M														
COMBAT USE BY ALLIES			H	M	L			M	H	H	H		M			L		
TOTAL	C	C	C	C	C	C	C	C	H	H	H	M	H	H	H	H	H	H

COUNTRY	HAITI	NICARAGUA	HONDURAS	EL SALVADOR	ISRAEL	INDIA	CUBA	MOZAMBIQUE	RHODESIA	GREECE	ICELAND	NEW ZEALAND	AUSTRALIA	FINLAND	KENYA	UGANDA	RUANDI	
CONFLICT POTENTIAL	-7	-3	-6	-5	X	X	-6	X	X	X	X	X	X	X	X	X	X	X
TRAINING																		
MILITARY CONSTRUCTION							L											
NON-MILITARY										L	L	L	L	L				
INVASION		L	L		M	M	M											
SHOW OF FORCE	M	M	M	M														
ARMED INSURRECTION		L	L	L				M	M						L	L	L	L
COMBAT USE BY ALLIES					L	M							L					
TOTAL	M	M	M	M	M	M	M	M	M	L	L	L	L	L	L	L	L	L

TABLE II

WEIGHTING OF
DEPLOYMENT AREAS

TURKEY	JORDAN-LEBANON	ARABIA	PAKISTAN	IRAQ	REP. OF CONGO	CAMBODIA	LAOS	MALAYA	BURMA	BRAZIL	PERU	VENEZUELA	PARAGUAY	COLUMBIA	AFGHANISTAN	IRAN	DOMINICAN REP.
[illegible]	X	X	X	X	X	X	X	X	X	-2	0	-5	-4	-5	X	X	-6
[illegible]		M	L						L						L		
		L			M							L					
		L	L							L	L	M			L		
			L			M			M								
[illegible]	H	H	H	H								L			M		M
				L	M	M	M	M	M	M	M	M	M	M	M	M	L
[illegible]	H	H	H	H	M	M	M	M	M	M	M	M	M	M	M	M	M

2

UGANDA	RUANDI	BECHUANALAND	S.W. AFRICA	LIBYA	ANGOLA	MOROCCO	SPANISH SAHARA	COSTA RICA	BOLIVIA	CHILE	EQUADOR	ARGENTINA	LIBERIA
X	X	X	X	X	X	X	X	2	-6	-2	-2	-5	X
				M	L			L					
									L	L	L	L	
				L	L	L	L						
					L			L	L	L	L	L	L
	L	L	L			L		L		L	L	L	L
L	L	L	L	M	L	L	L	L	L	L	L	L	L

KEY	
X	Not used as criterion
-	Unstable values
Probabilities of Usage	
L	Low
M	Moderate
H	High
C	Certain
	(NOTE: Blank cells indicate negligible probability.)

SECTION II

BASING

EXISTING BASES

With the deployment areas defined, the next step is to determine the available airfields in these areas and their pertinent characteristics.

DATA SELECTION

In conducting a detailed examination of existing airfields, the following data have been chosen as information needed to properly define requirements for EMS.

(1) Location -- Operator, name of country, and latitude and longitude. These data will be used to determine political implications, location relative to major USAF bases, climatic effects due to latitude, and availability of airfields for military operations.

(2) Runway -- Runway data will consist of the number of runways and length, width, strength, and surface materials of the longest runway. These will be used to determine the suitability of bases for military operation, i.e., whether a particular type of aircraft can be operated from the runway and the number of takeoffs and landings that can be conducted without damage to the runway.

(3) Altitude -- This factor is used to determine the local variation in climate and provide a first-order approximation of surrounding terrain characteristics. Further effects, such as local terrain interference with line-of-sight have been omitted for lack of complete data. With the capability for remote operation, local terrain variation is an operational, rather than a design problem.

(4) Accessibility -- This is defined as the distance from a fixed facility to the base. The distance from a town, road, and railroad will determine availability of existing communication and transportation. The distance from the primary base (which are given in Figure 6 and Table III) will determine the ease of logistics support, such as emergency maintenance and supply. This distance, combined with the number of bases within 20 n.mi., determines the possibility of using the satellite base operations concept. The limit of efficient remote operation for present EMS equipment is about 20 n.mi. The number of bases within 50 n.mi. is included for all non-communist countries (except Europe and the United States) to account for expected state-of-the-art advances in EMS systems. (Only those bases which are shown in Reference (c) were counted in determining the number of bases within 20 n.mi. and 50 n.mi.). The distance from an AFCS mobile squadron is included to determine the deployment range for the AN/TSQ-47.

(5) Facilities -- Facilities of interest are navigation and landing aids existing at the base such as runway and high intensity lights, light beacon, tower, GCA, ILS, DF, VOR, and TACAN.

(6) Climatic Environment -- The bases are correlated with environmental regions. A discussion of these regions is presented in Section III.

DATA PRESENTATION

The information on United States bases was taken from Reference (c), (d), (e), and (f) and the foreign base data was obtained from References (c), (d), and (f). The information has been placed on punched cards, sorted into meaningful categories, and presented in Figures 7 to 17, and Table IV. Figure 18 shows the countries which have been investigated in this report. The data obtained to date will be supplemented and updated as additional information becomes available. Primary bases are established U.S. military bases with security, maintenance and servicing facilities, etc. These will be used when possible and will serve as supply centers when other bases are employed. These bases can also serve as the major base in a multiple base complex, since, as shown in Figure 17, 78% of the bases in the U.S. are within 100 miles of a primary base. Even when primary bases are not as available (as in some foreign countries) there is a high incidence of multiple complexes (i.e. bases within a radius of 20 or 50 n.mi.) (Figure 13 b,c).

The airdromes of the world are predominantly civil airfields with one unpaved runway and no landing or navigation aids. Of the runways of sufficient length and surface for operating modern military aircraft, many have runway lighting and beacons, but few have additional aids. AN/TSQ-47 should be considered an integral part of any deployment to airfields other than the primary bases.

Within the U.S., most bases are easily accessible by road, and are near a railroad. This is not true of other parts of the world. Therefore, the AN/TSQ-47 can not be transported overland but must be delivered to its operating site by air. This indicates an advantage in packaging in small enough units for short-range transport by helicopters.

There are airports in every environmental region. However, correlation of these data demonstrates that alternate bases can be chosen to avoid the extreme areas in most circumstances. For example, only 17 of the 4484 foreign bases collected to date are at altitudes of above 6000 feet and more than 50 miles from a base below 6000 feet. Using the estimate that a rise of 1000 feet increases the required field length by 9%, Figure 12b shows that these runways are generally too short for use by modern military aircraft.

To estimate the confidence level of this information, data from Reference (g) (a survey of 747 United States and Canadian, 503 European, and 103 Far East airdromes as listed in Radio Facility Charts were checked (Figures 19 to 23). These include runways located in NATO or allied countries, and exclude "neutral" European countries, Finland, Sweden, Austria, and Switzerland, as well as the Communist Bloc. General runway distribution curves for the United States, Canada, Europe, and the Far East are plotted.

The conclusions from these comparisons, though not immediately obvious from this data are that data from only one source are generally incomplete, and information on the larger bases is more readily available than smaller base data. These facts will provide a basis for future analysis of the data.

SUITABLE SITES

In addition to the data gather on existing bases, information was also acquired on potential natural landing sites. These include ice-free sites in East Greenland and the Canadian Arctic, dry lakes, and deserts.

ICE-FREE ARCTIC SITES

The data on ice-free sites in the Canadian Arctic were obtained from Reference (h) and that on East Greenland from Reference (i). A map of these sites is given as Figure 24. There are 73 documented sites suitable for aircraft landings -- 51 in the Canadian Arctic and 22 in East Greenland.

The coastal area of East Greenland is a complex of glaciated mountain highlands and fringing lowlands. Much of the lowland area has been modified by the deposition of materials washed out beyond the glacier.

The Canadian Arctic, i.e. that area of Canada north of latitude 65°, may be geographically divided into two regions: (1) The northern Canadian mainland and (2) The Canadian Arctic Archipelago. The Archipelago is a geological extension of the North American continent. This northernmost land area was initially altered to its present state during the Pleistocene period. Arctic Canada was first depressed by the great weight of the Pleistocene ice sheets and then partially drowned by the widespread rise of sea level when the preponderance of this ice melted. The islands are now emerging from this depression as shown by the many raised beaches which now exist along the coastlines.

The Canadian Arctic is geologically similar to the other parts of the continent. The exposed rock formations are, in general, successively younger from southeast to northwest and are most generally grouped into a stable region, a relatively mobile region, and a coastal plain.

Permafrost, a condition of the soil (or rock) below the surface in which the temperature has been below freezing for at least two years, is prevalent in Greenland and the Canadian Arctic.

Permafrost has been divided into the continuous zone, in which Greeland and the Canadian Arctic are located, and the discontinuous zone in which permafrost intermittently exists in combination with unfrozen ground. The thickness of permafrost and the depth to which it annually thaws varies with the locality. At Resolute on Cornwallis Island, the permafrost is thought to be about 1,300 feet deep and annual thawing does not exceed 12 inches; at Norman Wells it is about 150 feet thick and thawing occurs in the upper 4 to 6 feet; at Hay River the permafrost is only 5 feet thick and almost completely thaws during the summer months.

Permafrost is very sensitive to temperature differences. In undisturbed areas a condition of equilibrium has been established between the permafrost and the surface of the ground and during normal temperature variations, the permafrost neither builds up nor breaks down. Any natural or man-made change in the natural insulating cover at the ground surface will upset this thermal balance and start the permafrost thawing. This alone is a major incentive for the location of "natural" landing sites, and their utilization in a relatively undisturbed state.

DRY LAKES AND DESERT AREAS

Information on 193 dry lakes and 48 intermittent dry lakes in the U.S. and 475 additional potential natural runway sites throughout the world was taken from Reference (j). The term "dry lake" refers to a specific geologic formation. The dry lakes formed in the United States are located in California, Arizona, Nevada, Utah, New Mexico, Colorado, and parts of Texas. They co-exist with arid environments and are formed in undrained topographic depressions. The geological environment for their formation may be summarized as follows: (1) There must be an extreme topographic relief to provide a water shed for the run-off material which is carried into the basin, (2) The climatic condition must be such that more precipitation will fall in the higher elevated areas than in the adjacent depressed areas, (3) The vegetation in the depressed regions is slight because of the arid environment, which provides for a desert-like condition, (4) There must exist a depositional basin adjacent to the higher topograph, that is undrained, thus providing a place for silty material carried down by the run-off to deposit, (5) The evaporation of this standing run-off water must be pronounced to enable the suspended material to be deposited in this basin. The surface of the described dry lakes may consist of loose sand and dust. Some lake beds become slippery when rained upon. This is generally a very temporary situation, however, existing only during the rain and a few hours after.

There are lakes found in certain areas which are intermittently dry, and during the correct time of year these lakes will be suited for aircraft operation.

A list of the 193 dry lakes and 48 intermittent dry lakes in the United States is given in Reference (j) together with the state in which they are located, their latitude and longitude, their length in statue miles, their altitude, and their distance from the nearest town, road, and railroad.

Figures 25 to 31 summarize these data.

475 additional potential natural runway sites are found in 15 areas of the world, viz. Afghanistan, Africa, Arabia, Argentina, Australia, Bolivia, Chile, China, Ethiopia, India, Iran, Libya, Mexico, Pakistan, Peru, and the USSR. (Figures 25 and 31.) Africa contains the majority of these sites. They are primarily confined to the "Horse Latitude" region (15° - 45° North and South of the Equator). During the past Ice Ages these areas were active in erosion and drainage and large accumulations of loose sediments have been made available. Now that the great ice sheets have receded, these sediments are left behind, disturbed only by dry winds and occasional rains.

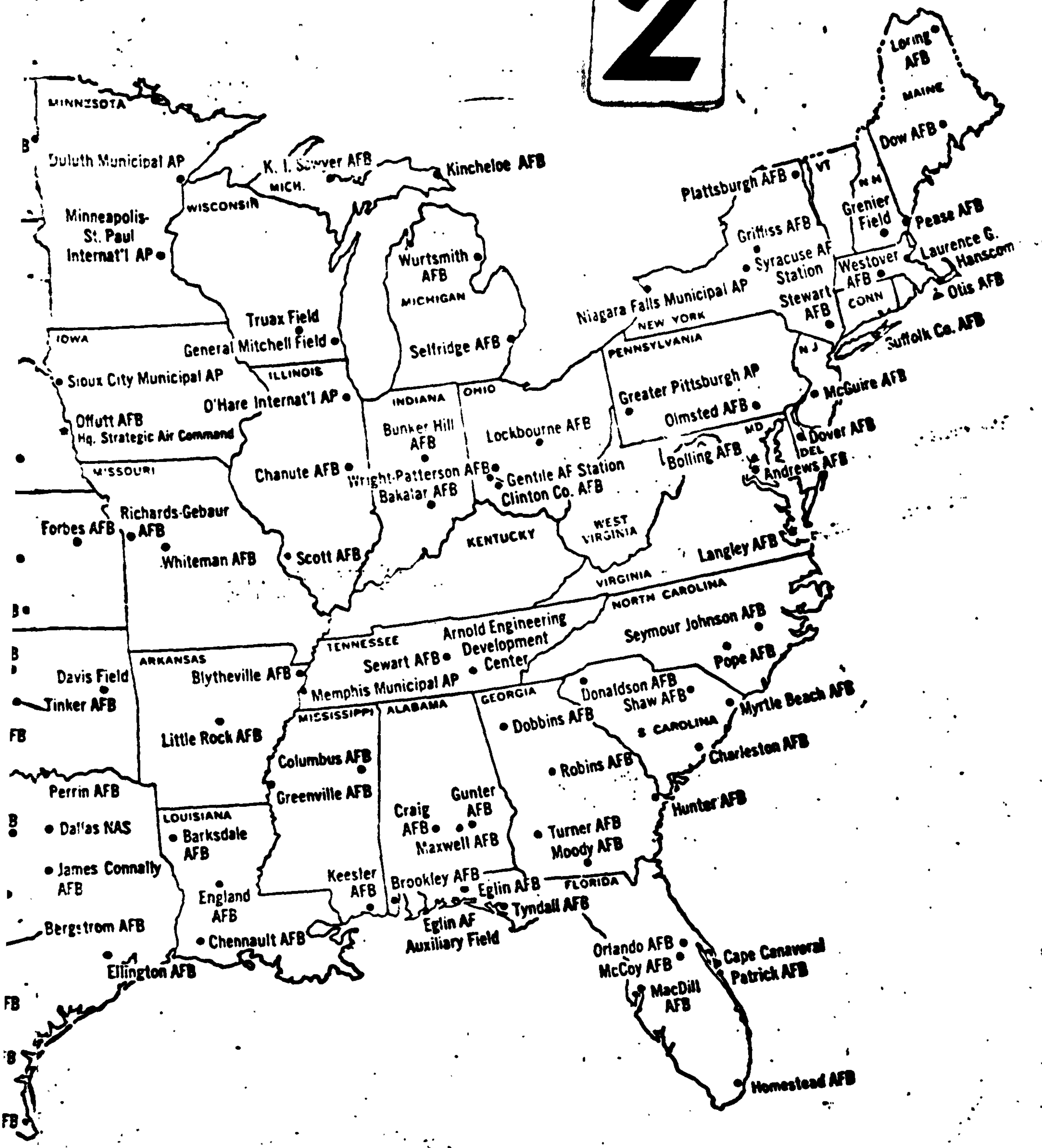
Most of the natural landing sites are not readily accessible by railroad or highway, but can be reached by light plane, helicopter, or overland travel.

A detailed geologic and topographic analysis would be required for each potential natural landing site in order to determine its actual applicability.


WASHINGTON
Paine AFB
Larson AFB
McChord AFB
Spokane Internat'l AP
Fairchild AFB
MONTANA
Malmstrom AFB
Glasgow AFB
NORTH DAKOTA
Minot AFB
Grand Forks AFB
MINNESOTA
Duluth Municipal AP
Minneapolis-St. Paul Internat'l AP
OREGON
Portland Internat'l AP
Kingsley Field
IDAHO
Mountain Home AFB
WYOMING
Francis E. Warren AFB
SOUTH DAKOTA
Ellsworth AFB
IOWA
Sioux City Municipal AP
Offutt AFB
Hq. Strategic Air Comm
NEBRASKA
Lincoln AFB
CALIFORNIA
NEVADA
Stead AFB
UTAH
Hill AFB
COLORADO
Lowry AFB
USAF Academy
Ent AFB
Peterson Field
KANSAS
Forbes AFB
Schilling AFB
McConnell AFB
MISSOURI
Richards-Geba AFB
Whitem
Beale AFB
McClellan AFB
Mather AFB
Castle AFB
Indian Springs AFB
Nellis AFB
Edwards AFB
Norton AFB
George AFB
March AFB
denberg AFB
Oxnard AFB
ARIZONA
Luke AFB
Williams AFB
Davis-Monthan AFB
NEW MEXICO
Kirtland AFB
Cannon AFB
Walker AFB
Holloman AFB
OKLAHOMA
Vance AFB
Clinton Sherman AFB
Tinker AFB
Altus AFB
ARKANSAS
Davis Field
Bly
Little R
TEXAS
Amarillo AFB
Reese AFB
Sheppard AFB
Perrin AFB
Carswell AFB
Dallas NAS
Dyess AFB
Webb AFB
James Connally AFB
Goodfellow AFB
Gray AFB
Biggs AFB
Randolph AFB
Lackland AFB
Bergstrom AFB
Ellington AFB
Kelly AFB
Laughlin AFB
Brooks AFB
Laredo AFB
Harlingen AFB
LOUISIA
Bark AFB
LASKA
Eielson AFB
Elmendorf AFB
OAHU, HAWAII
Wheeler AFB
Bellows AFB
Hickam AFB

Major

2



Major Active Air Force Bases in the United States

An *AIR FORCE* Magazine Map (As of August 15, 1961). **Figure 6**

TABLE III

PRIMARY BASES

Pacific Islands

Anderson
Iwo Jima
Johnson Islands
Kadena
Naha
Clark
John May

Korea

Kimpo
Kunsau
Osav
Pusan
Pyongtalk Auxiliary
Seoul Auxiliary

Japan

Ashuja
Brady
Chitose
Itazuki
Johnson
Kisarazu
Misawa
Yahota
Shiro
Tachikowa

Saudi Arabia

Dhahran

Morocco

Bengueri
Boulhaut
Nouasseur
Rabat Sale
Sidi Slimane

Libya

Wheelus

Newfoundland

Pepperrell
Stephenville

France

Chamblay
Chaumont
Deols
Dreaux
Etain
Evreux Fauville
Laon
Orly
Phalsbourg
Toul-Rosieres

Spain

Moron
San Pablo
Torrejon
Zaragoza

Netherlands

Camp New Amsterdam

Germany

Bitberg
Furstenfeldbruck
Giebelstadt
Mahn
Ramstein
Rhein-Main
Sembach
Spangdahlem
Templehof
Weisbaden

Greece

Athenai Airport

Italy

Aviano

Azores

Lajes Field

Puerto Rico

Ramey

England

Bushy Park
Denham Studios AS
Alconbury Abbots
Bentwaters
Bovingdon
Brize Norton
Bruntingthorp
Burtonwood
Chelveston
Fairford
Greenham Common
Lakenheath
Mildenhall
Sculthorp
Shepherds Grove
Upper Meyford
Wattesham
Welford
West Drayton
West Ruislip
Wethersfield
Woodbridge
High Wycombe
South Riuslip

Scotland

MTCA Prestwick
Kirknewton

Canal Zone

Albrook

Greenland

Narsarssuak
Sondrestrom
Thule

Labrador

Goose

Iceland

Keflavic Airport

Bermuda

Kindley

BASE OPERATOR

USZI

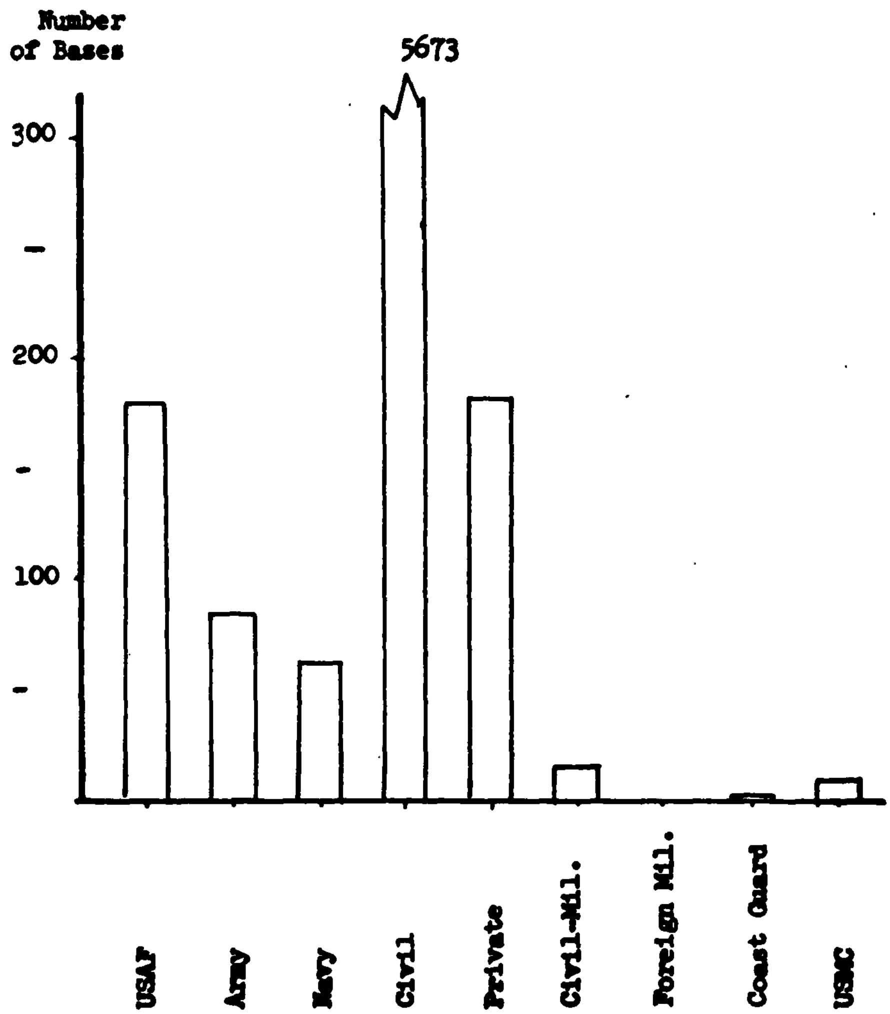


Figure 7a

BASE OPERATORS

FOREIGN

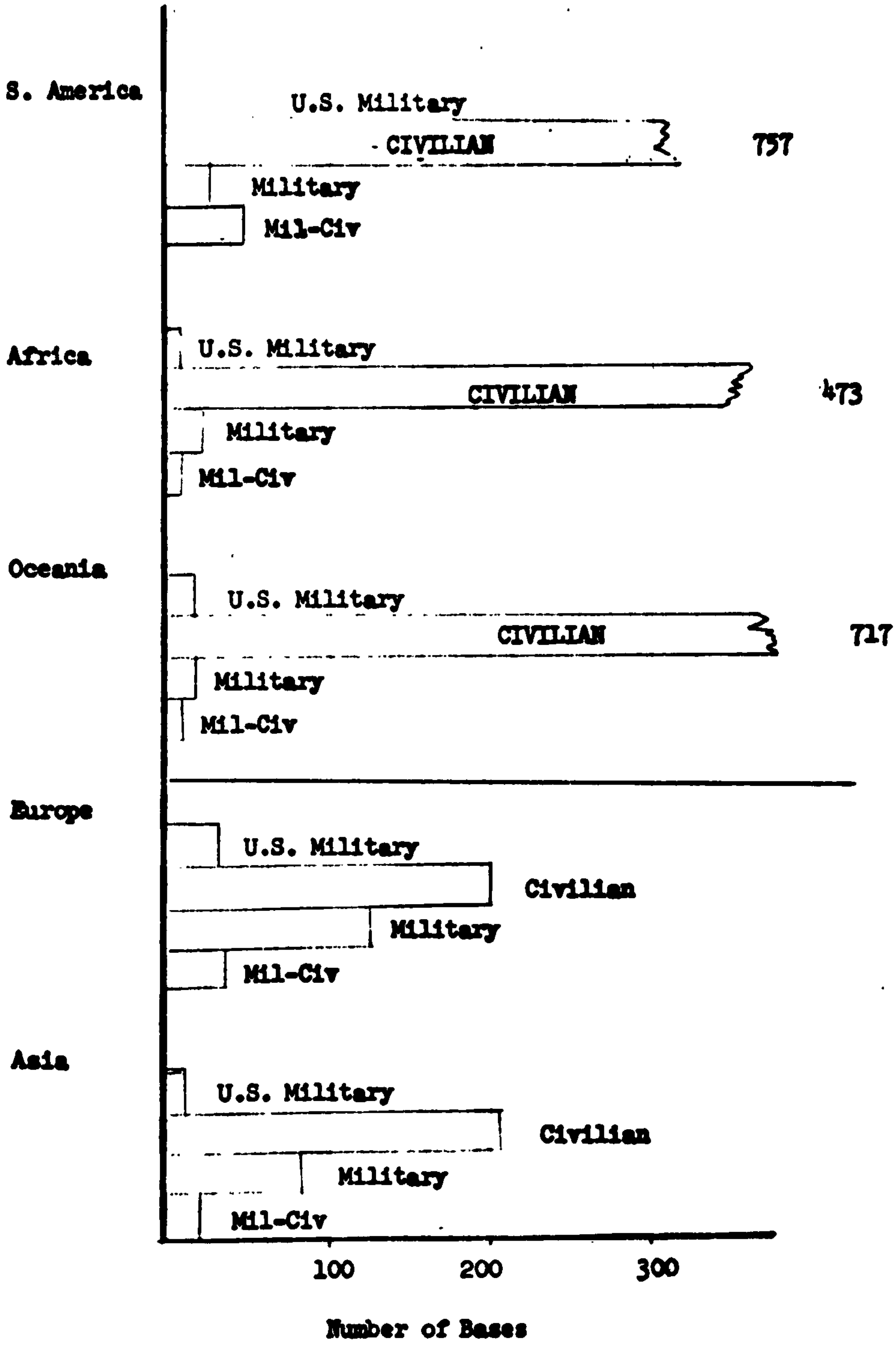


Figure 7b

NUMBER OF RUNWAYS

U.S. Z.I.

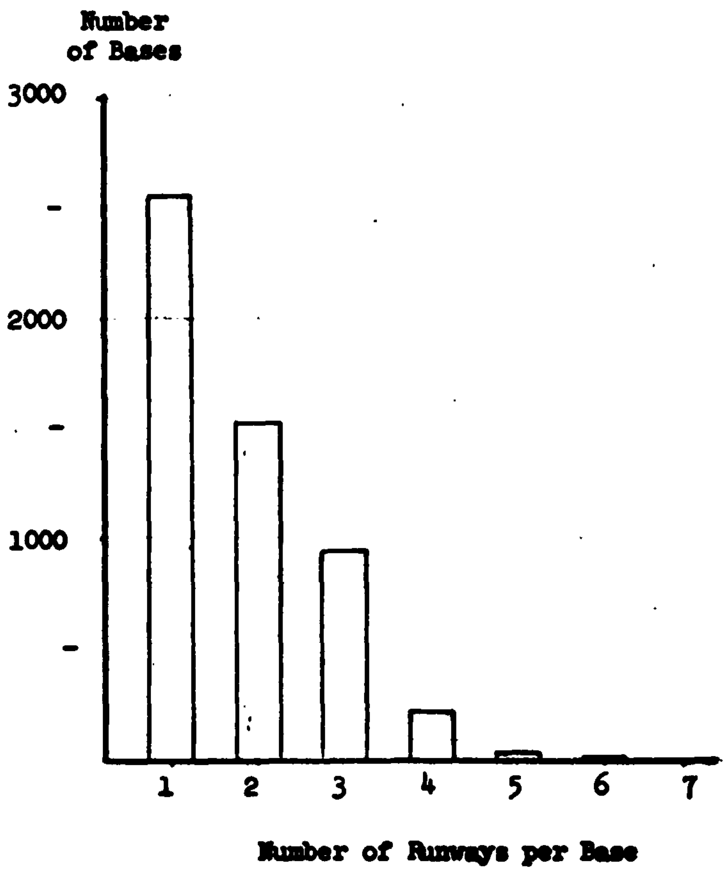


Figure 8

FACILITIES

U.S. Z.I.

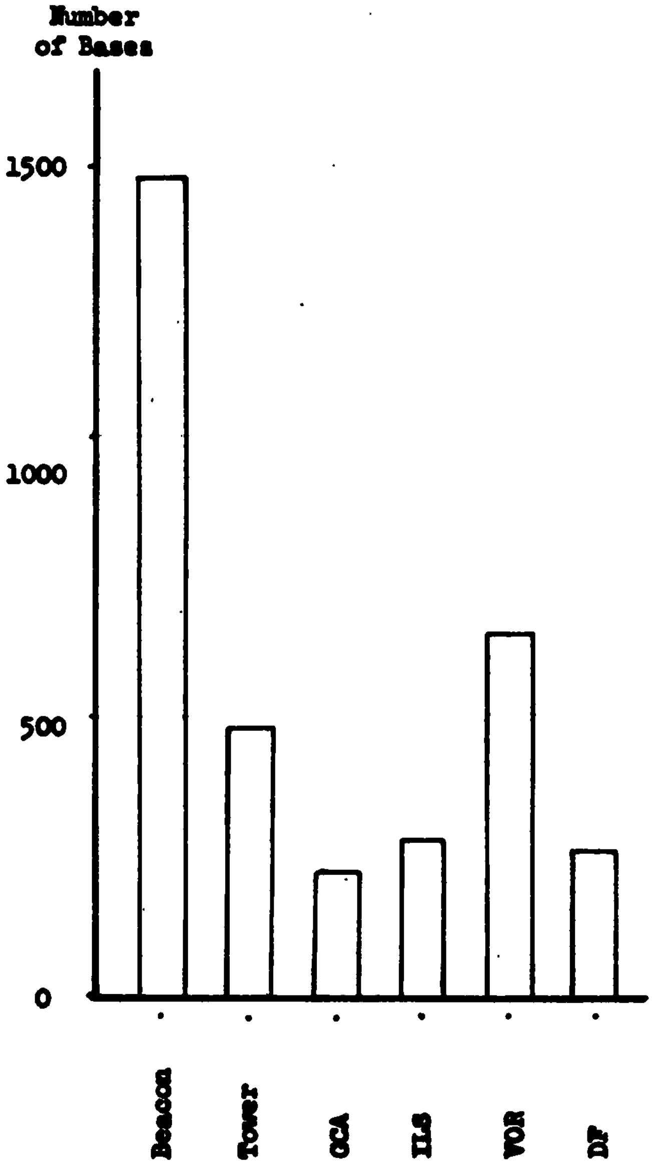
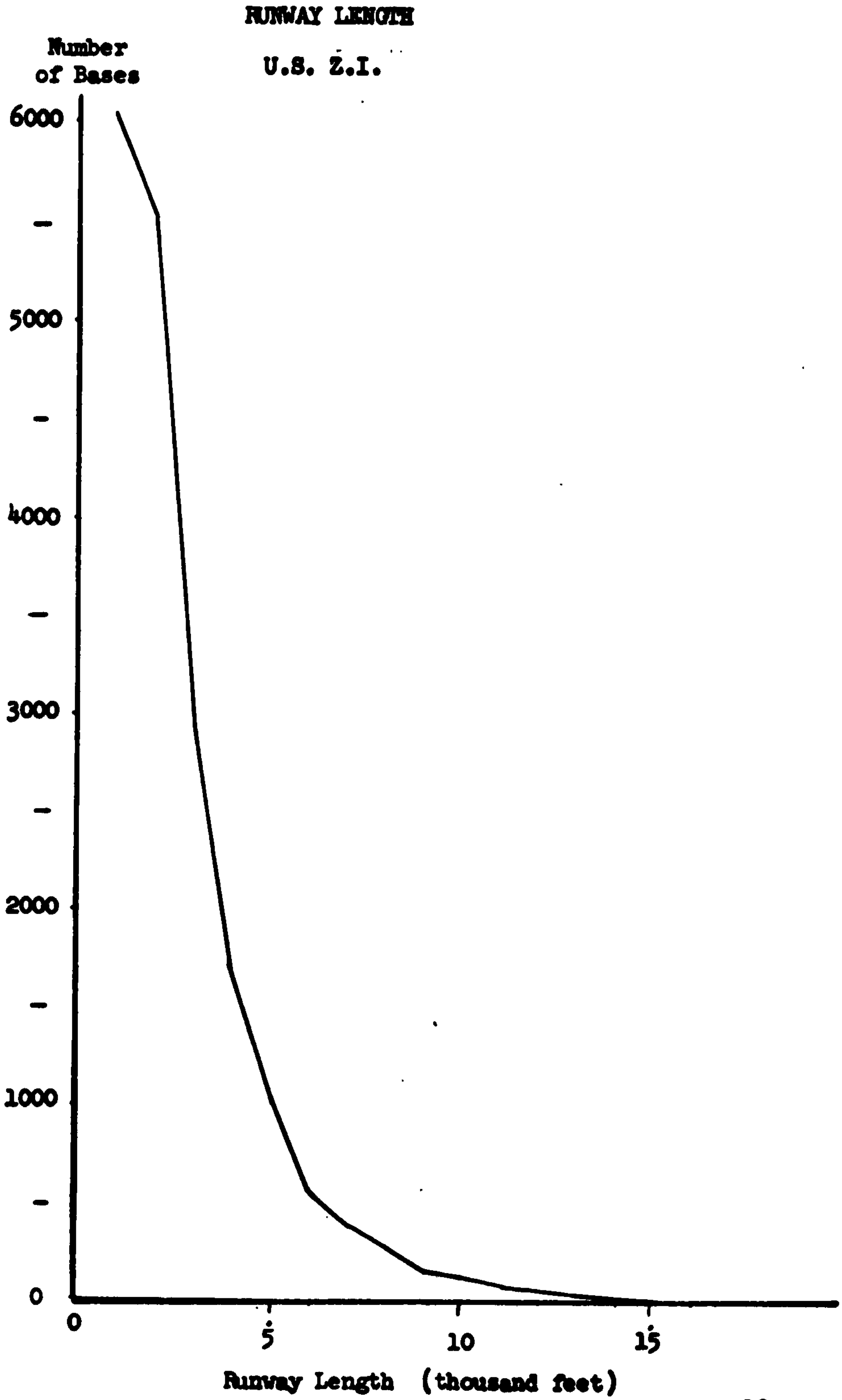


Figure 9



RUNWAY LENGTH
U.S. Z.I.
Number of Bases
6000
5000
4000
3000
2000
1000
0
0
5
10
15
Runway Length (thousand feet)

Figure 10a

RUNWAY LENGTH

AFRICA

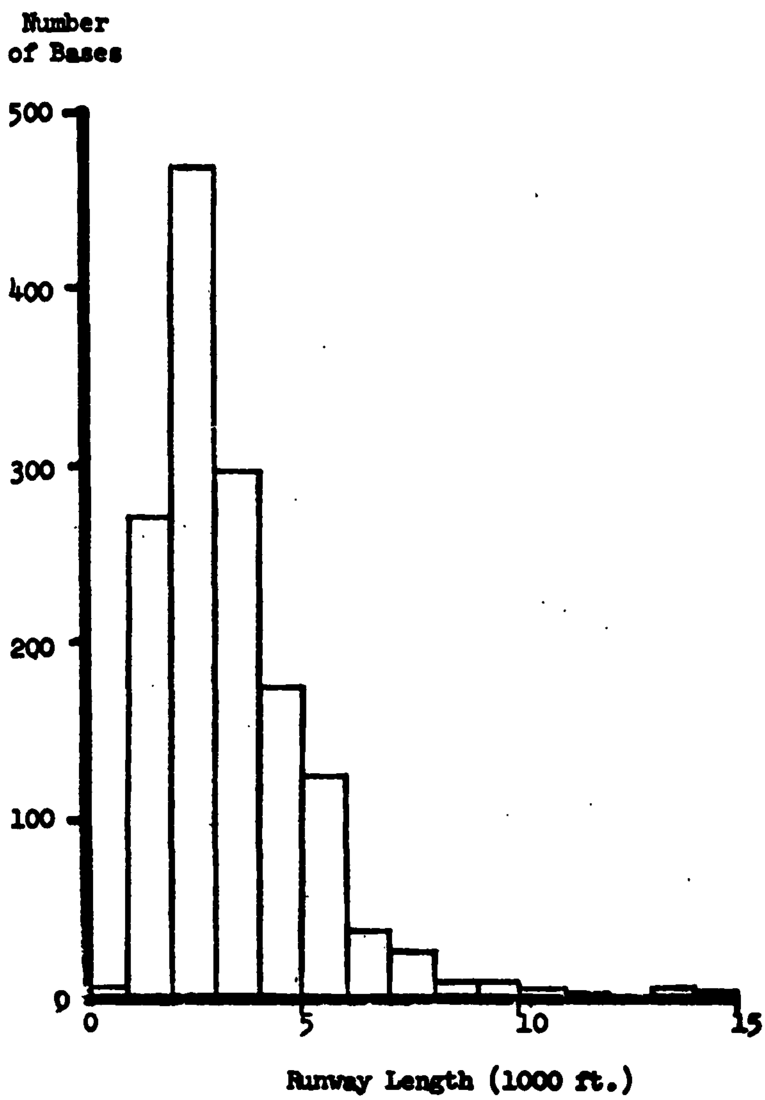


Figure 10b

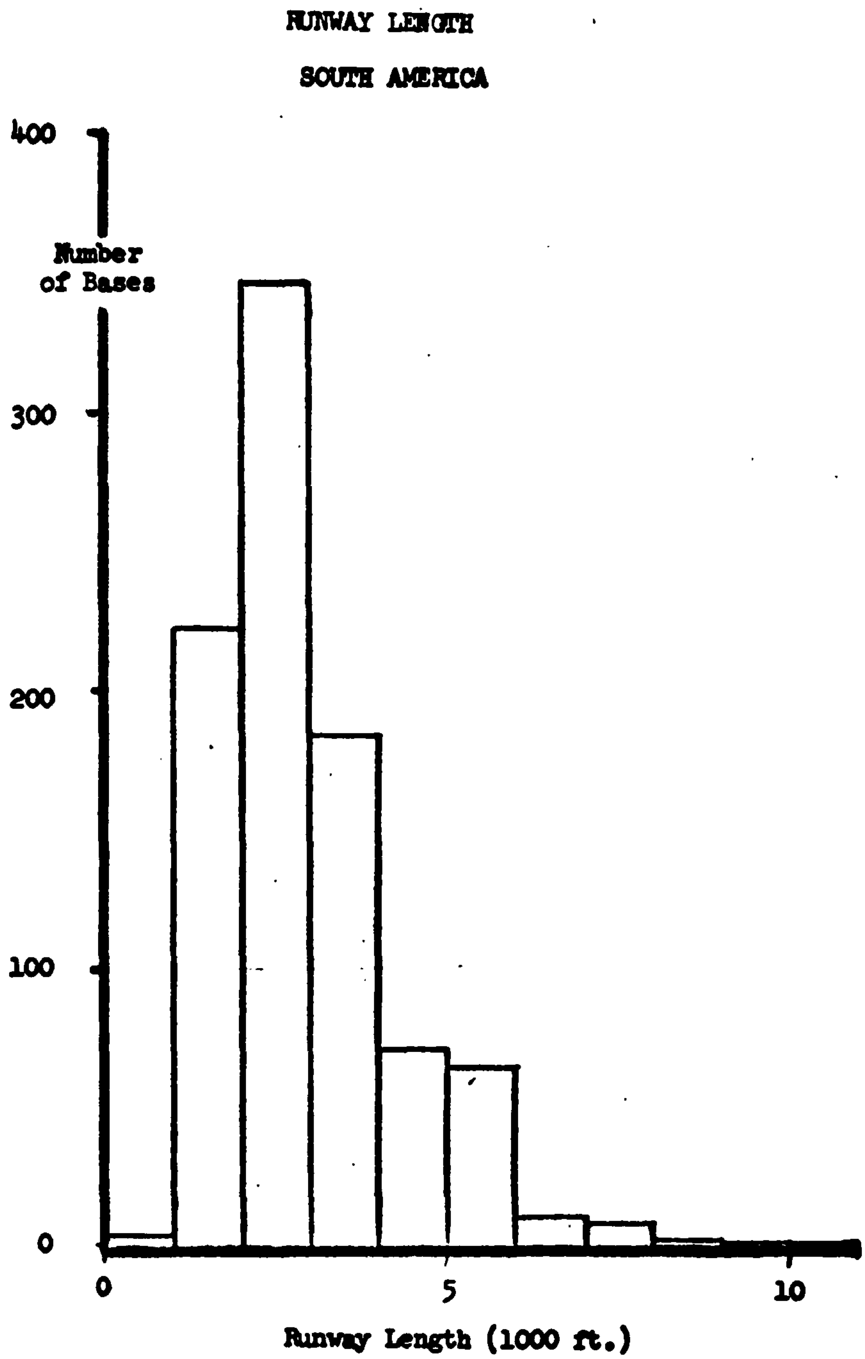

RUNWAY LENGTH
SOUTH AMERICA
400
300
200
100
0
Number of Bases
0
5
10
Runway Length (1000 ft.)

Figure 10c

RUNWAY LENGTH

AUSTRALIA AND OCEANIA

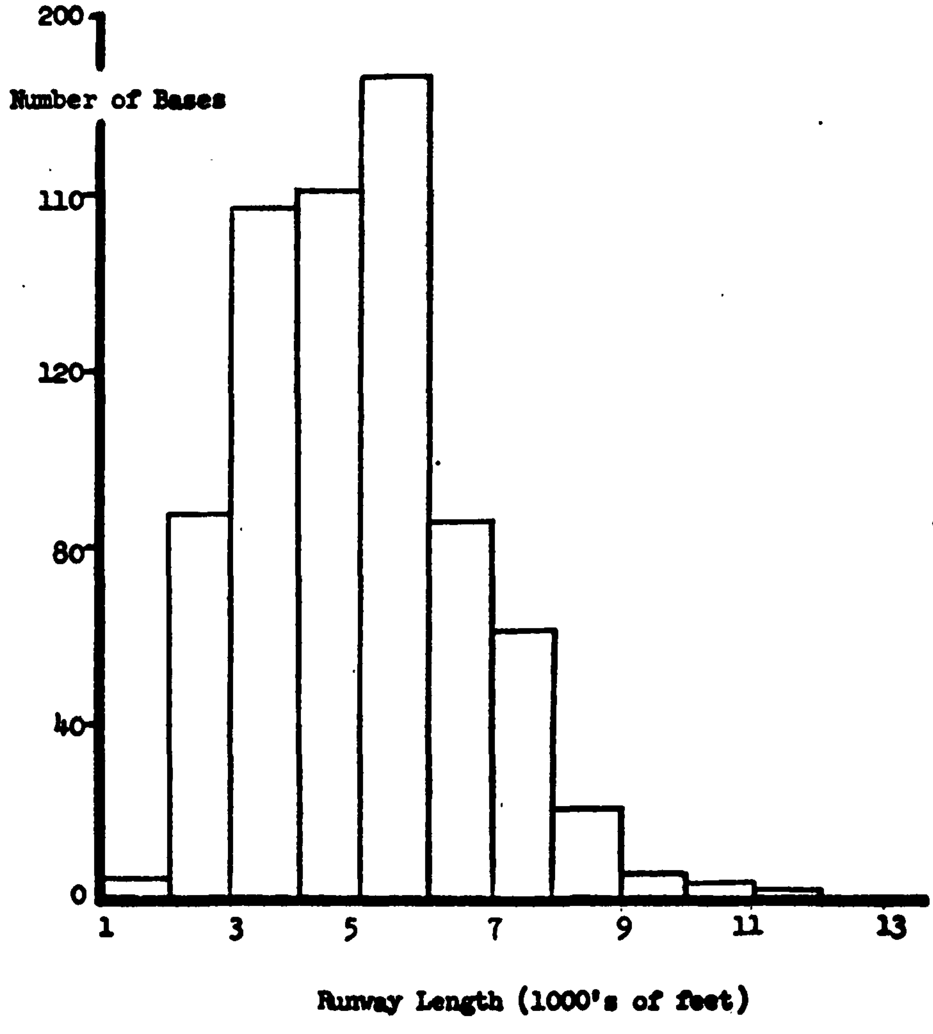


Figure 10d

RUNWAY LENGTH

EUROPE

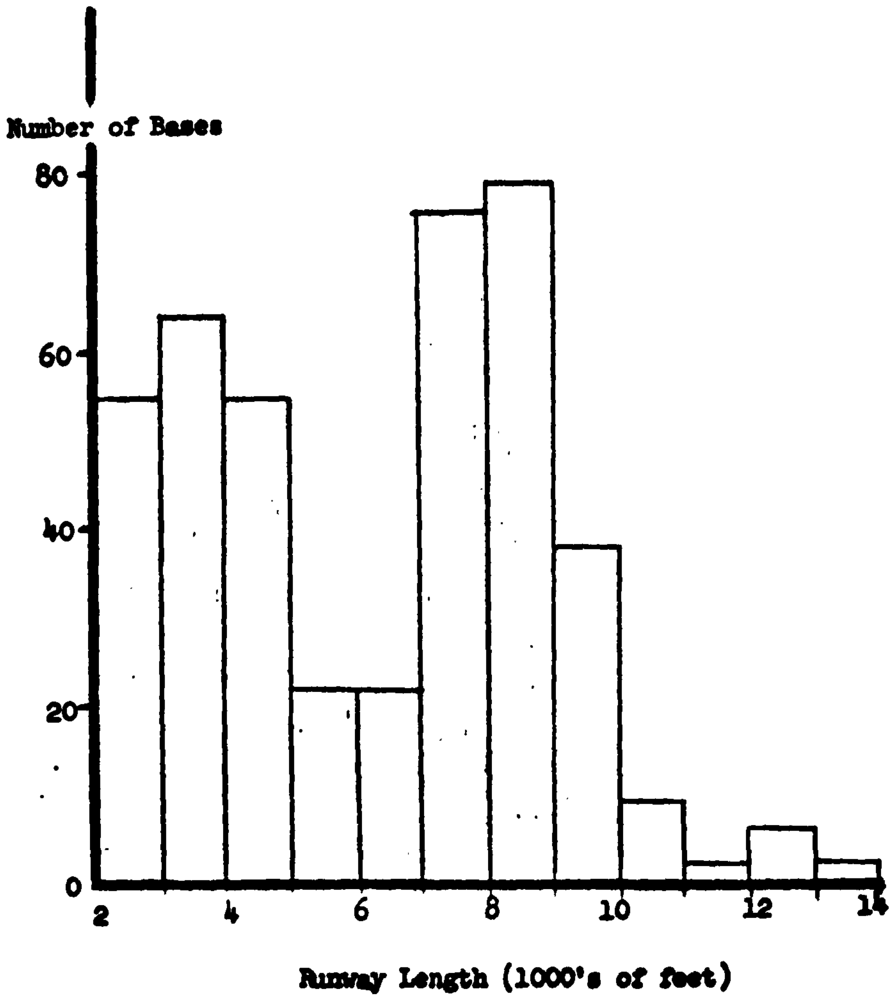


Figure 10e

RUNWAY LENGTH

ASIA

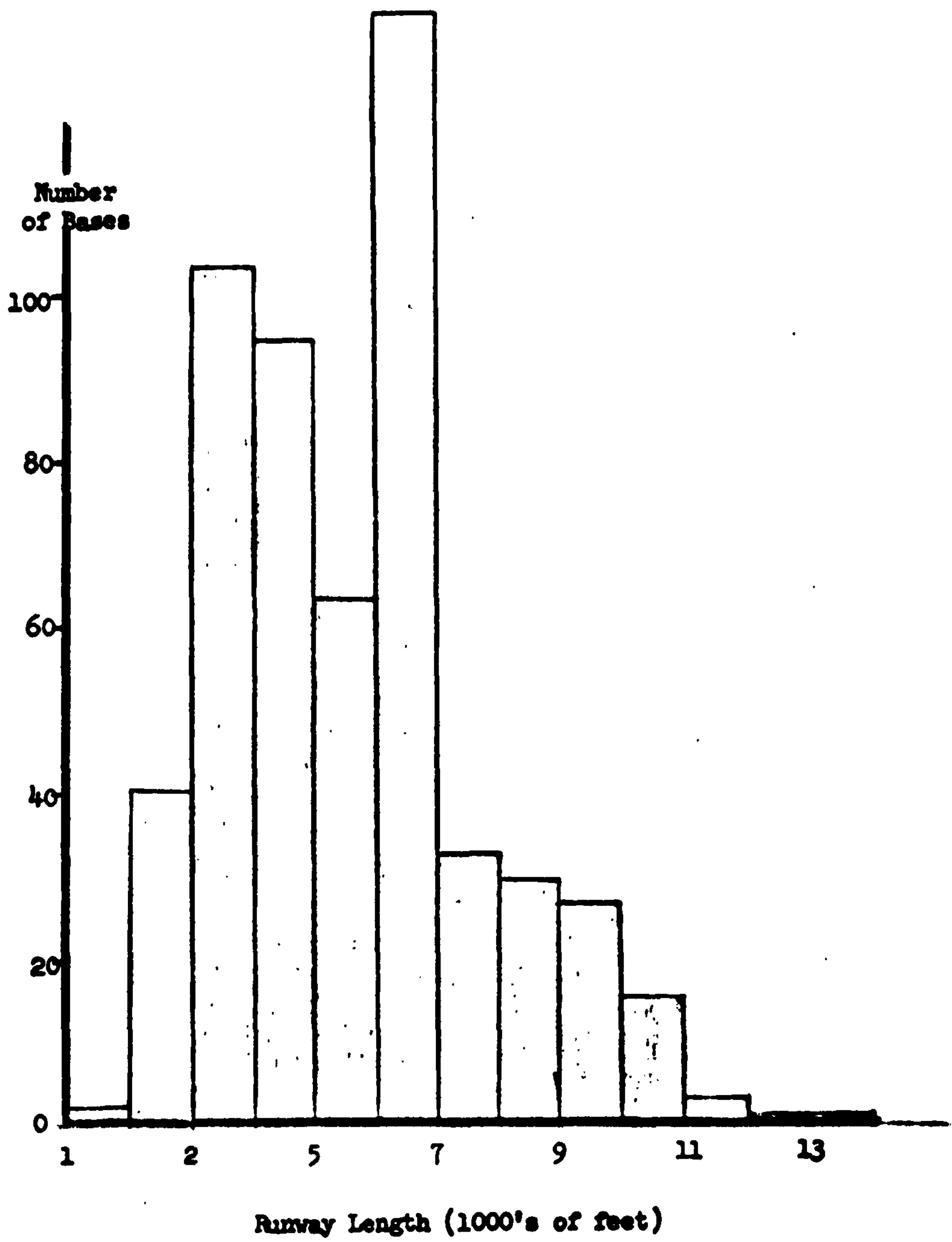


Figure 10f

ALTITUDE DISTRIBUTION

U.S. Z.I.

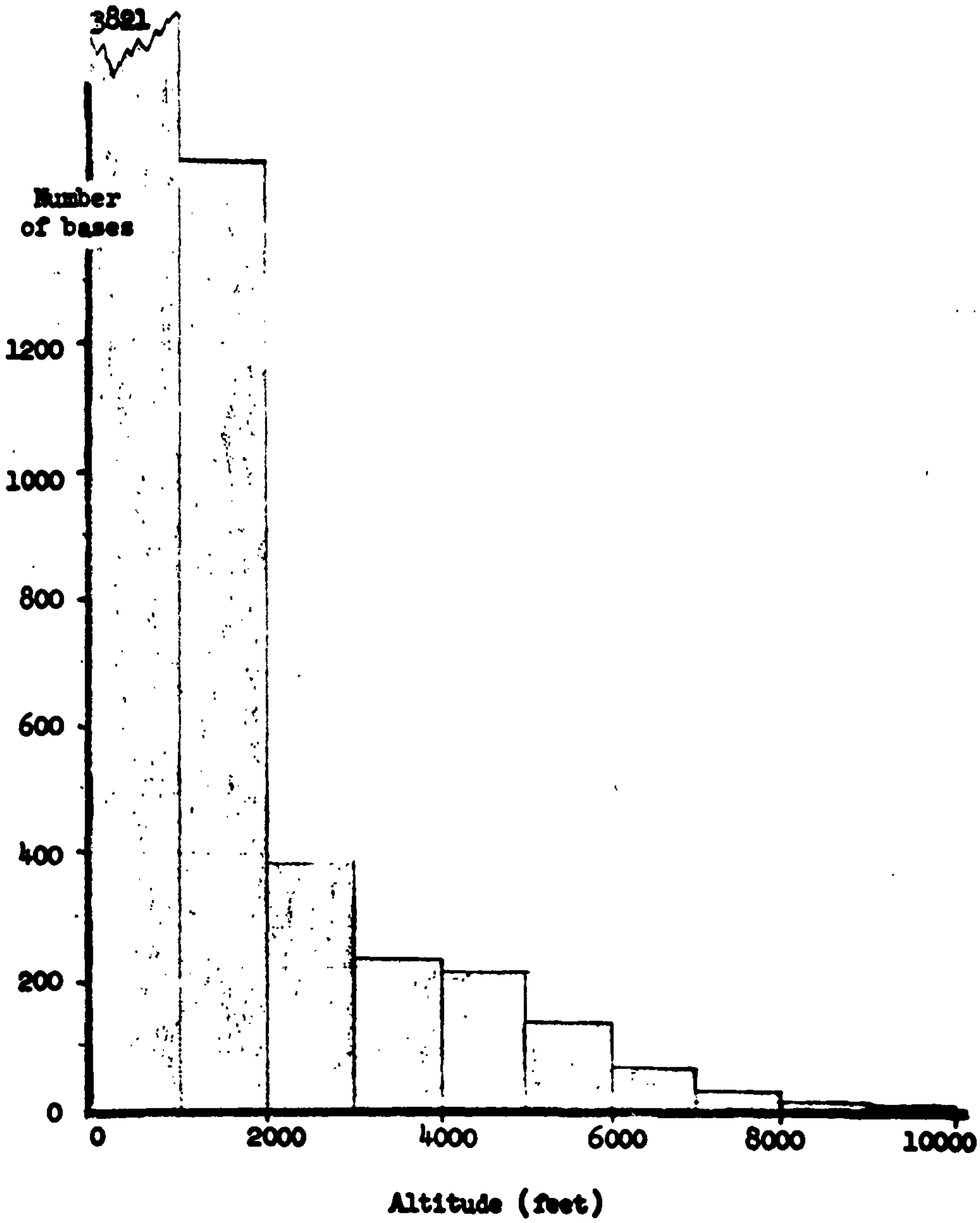


Figure 11a

ALTITUDE DISTRIBUTION

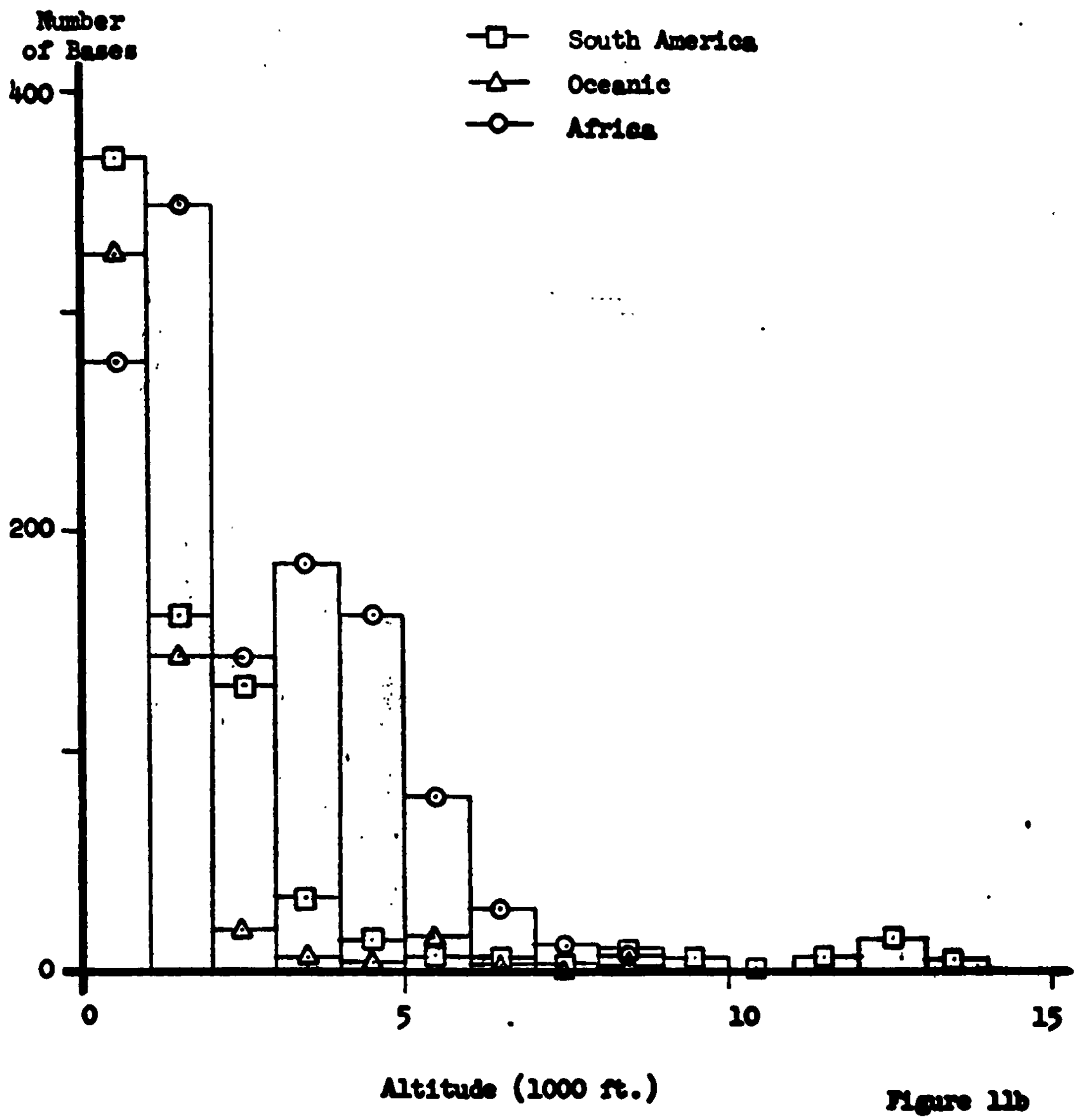


Figure 11b

ALTITUDE DISTRIBUTION

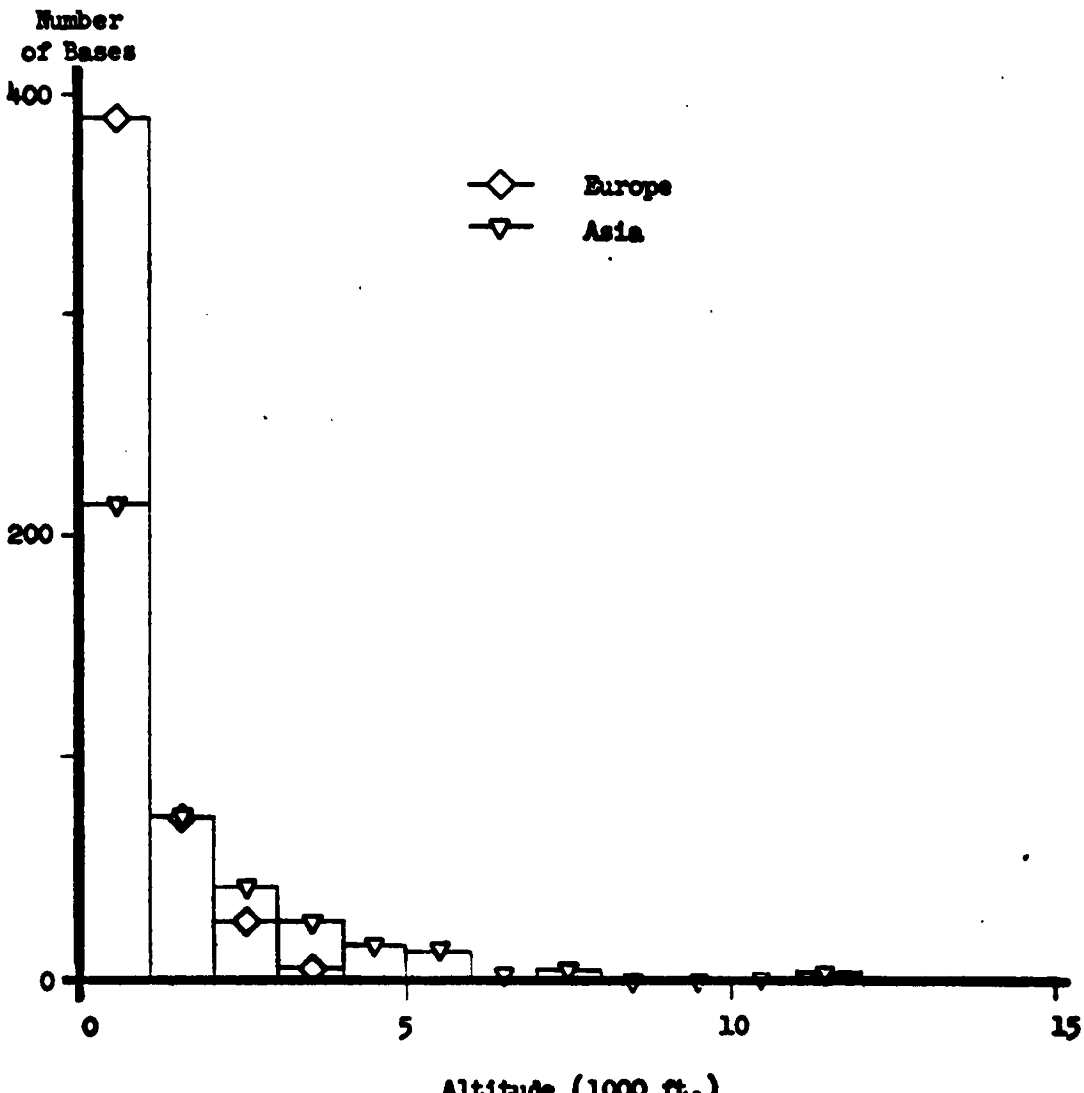


Figure 11c

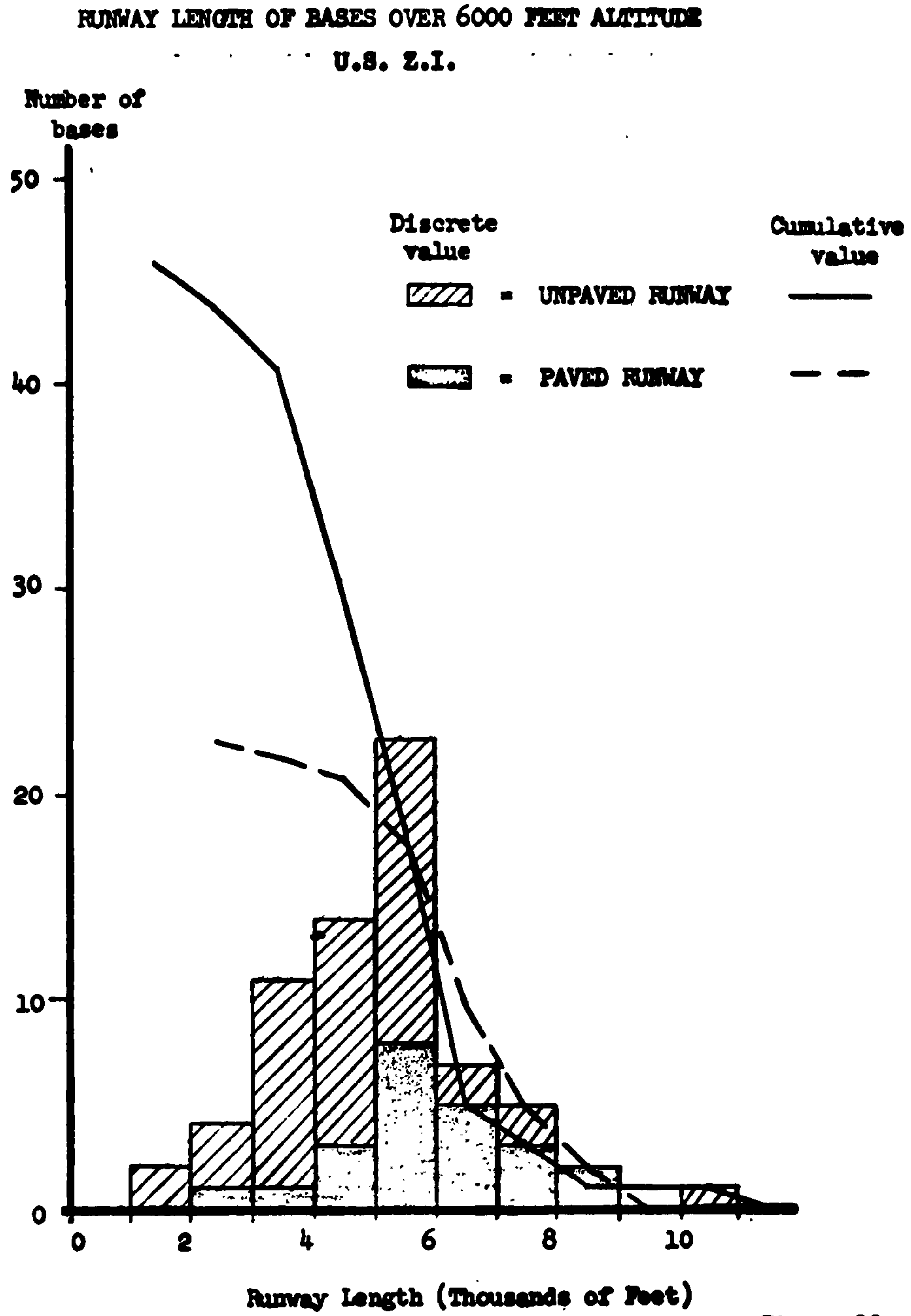

RUNWAY LENGTH OF BASES OVER 6000 FEET ALTITUDE
U.S. Z.I.
Number of bases
50
40
30
20
10
0
Discrete value
Cumulative value
= UNPAVED RUNWAY
= PAVED RUNWAY
0
2
4
6
8
10
Runway Length (Thousands of Feet)

Figure 12a

HIGH ALTITUDE BASE AVAILABILITY

FOREIGN BASES

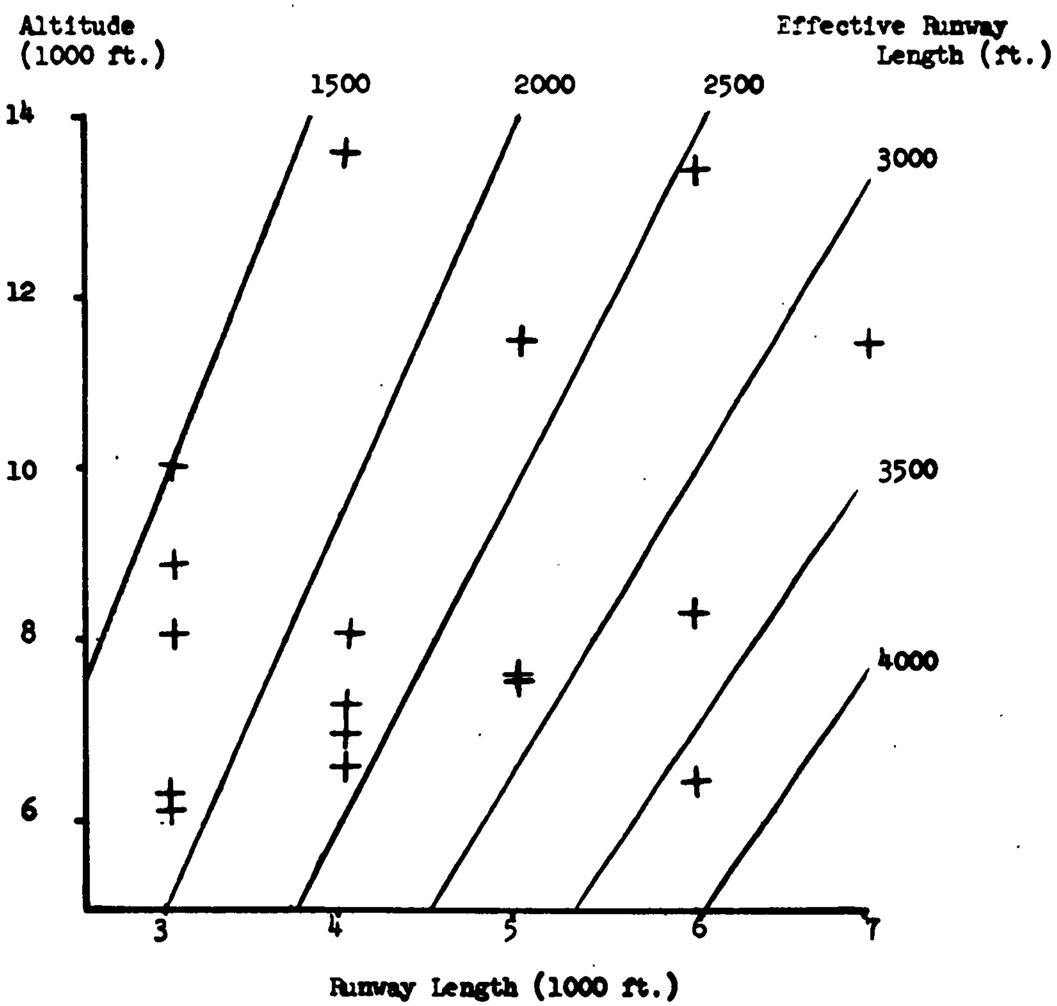


Figure 12b

MULTIPLE BASE COMPLEXES

U.S. Z.I.

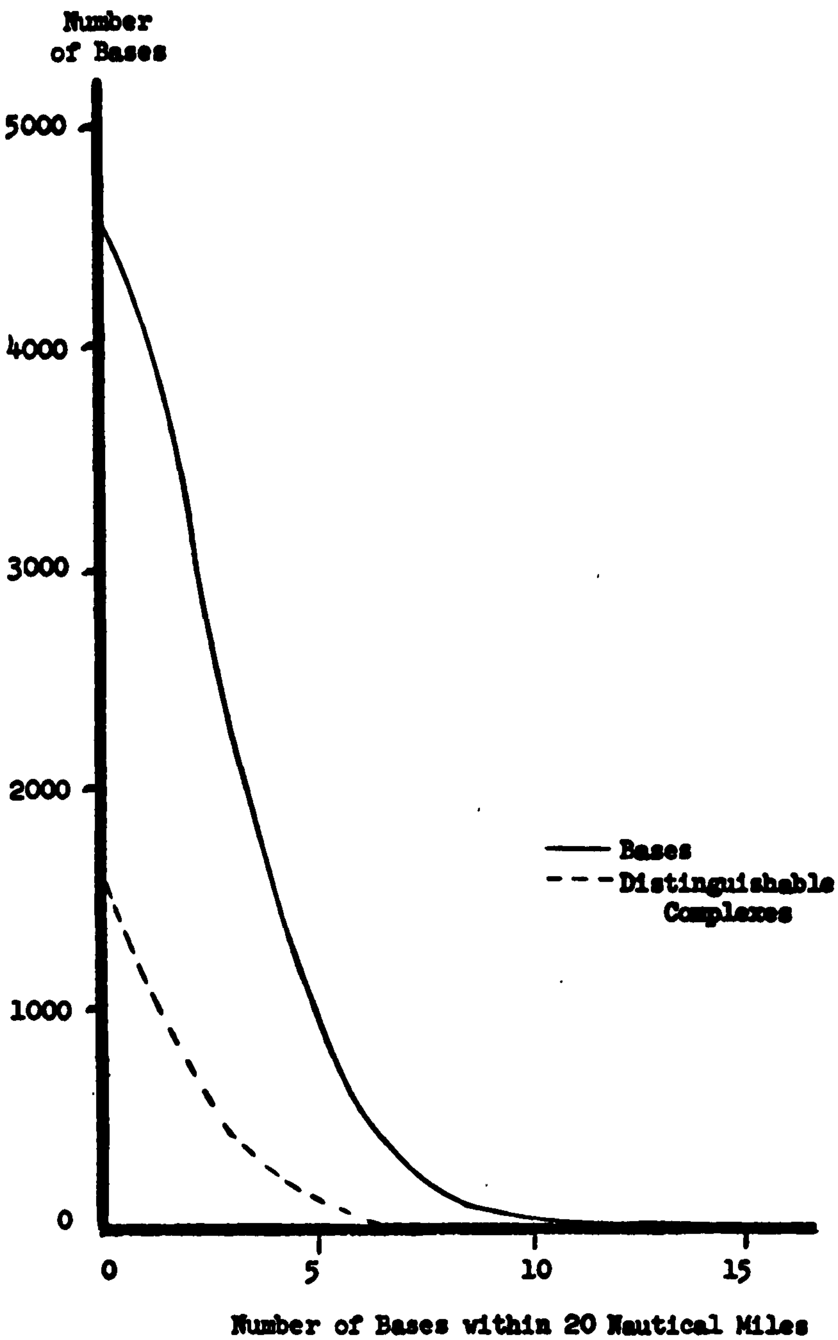
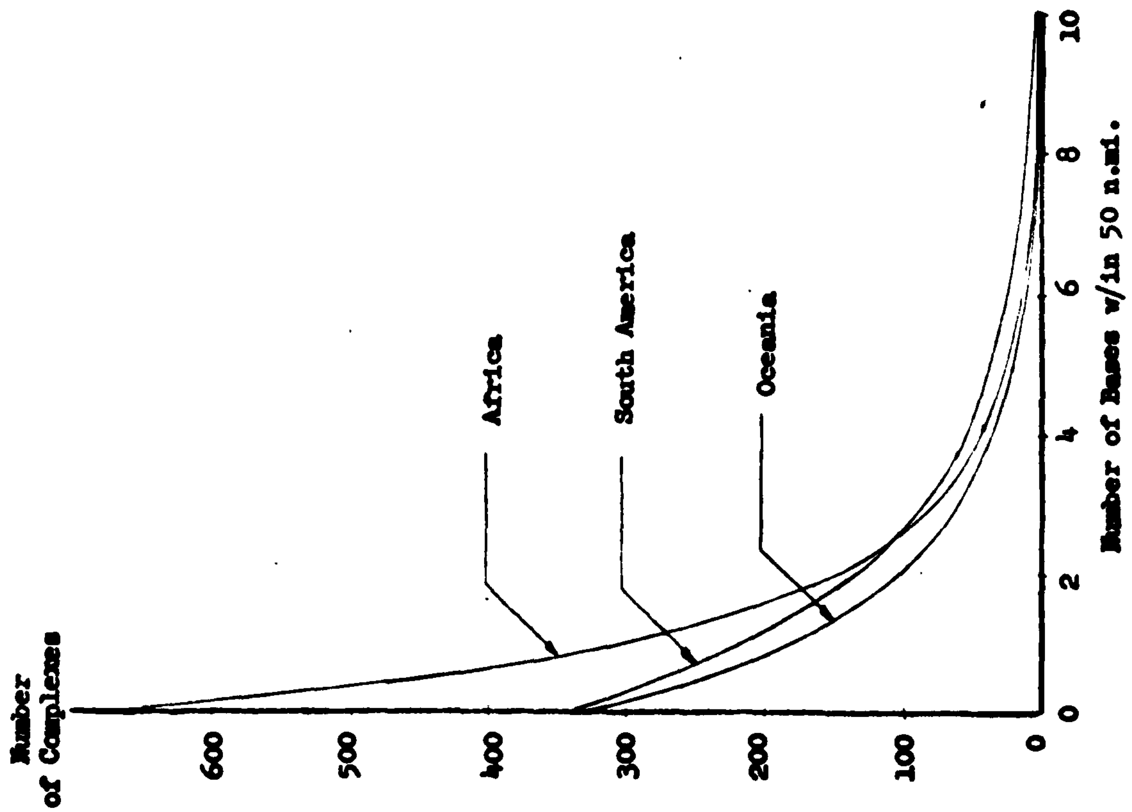


Figure 13a

MULTIPLE BASE COMPLEXES



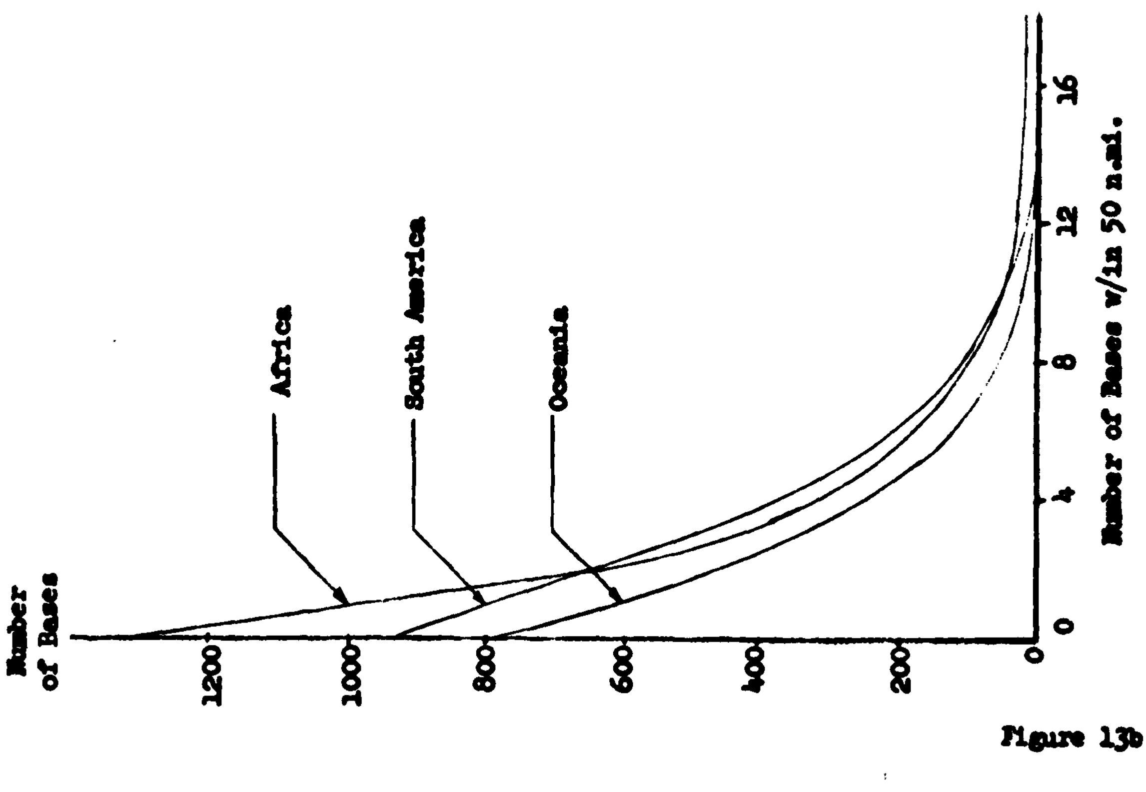


Figure 13b

MULTIPLE BASE COMPLEXES

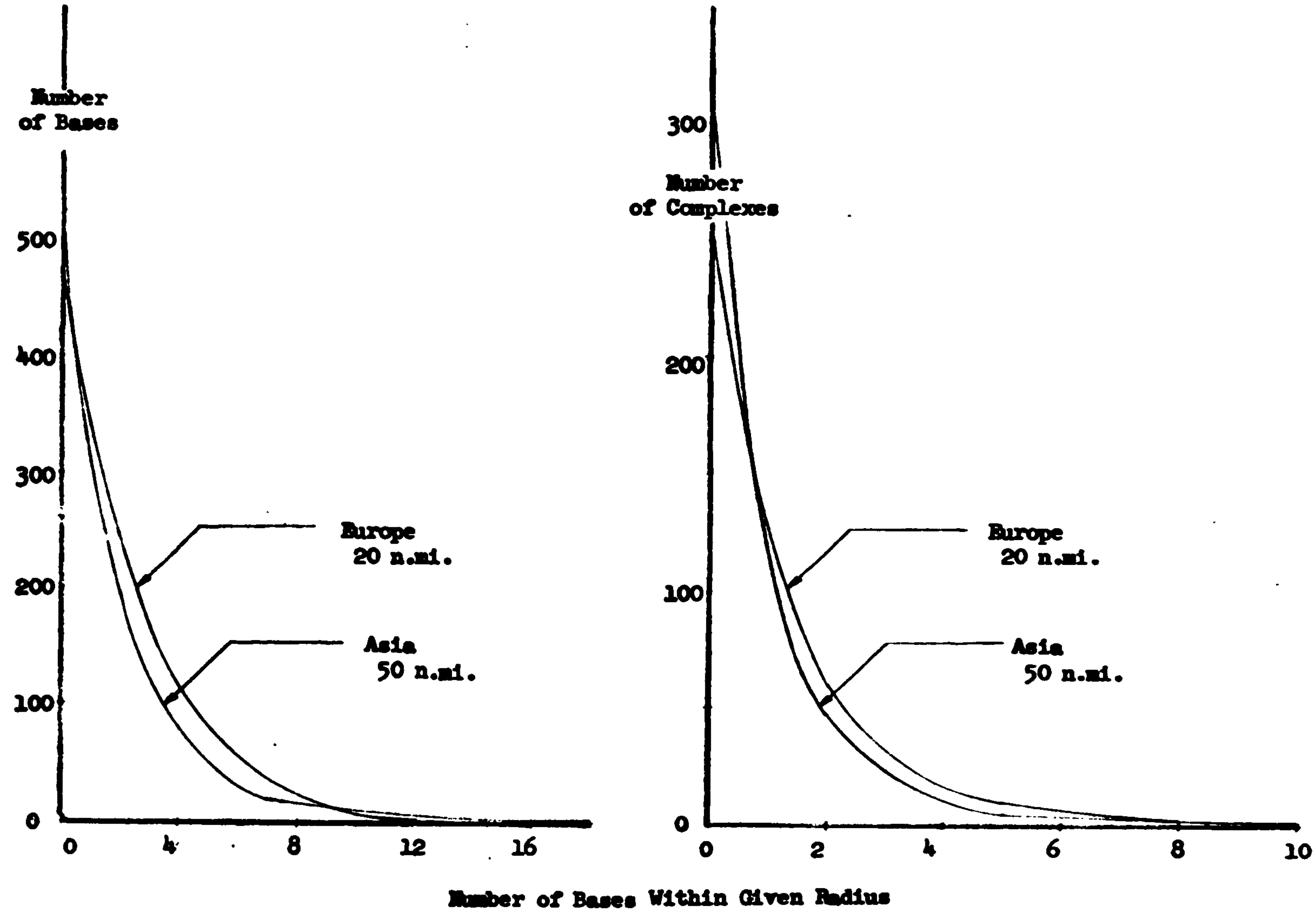


Figure 13c

RUNWAY SURFACE

U.S. Z.I.

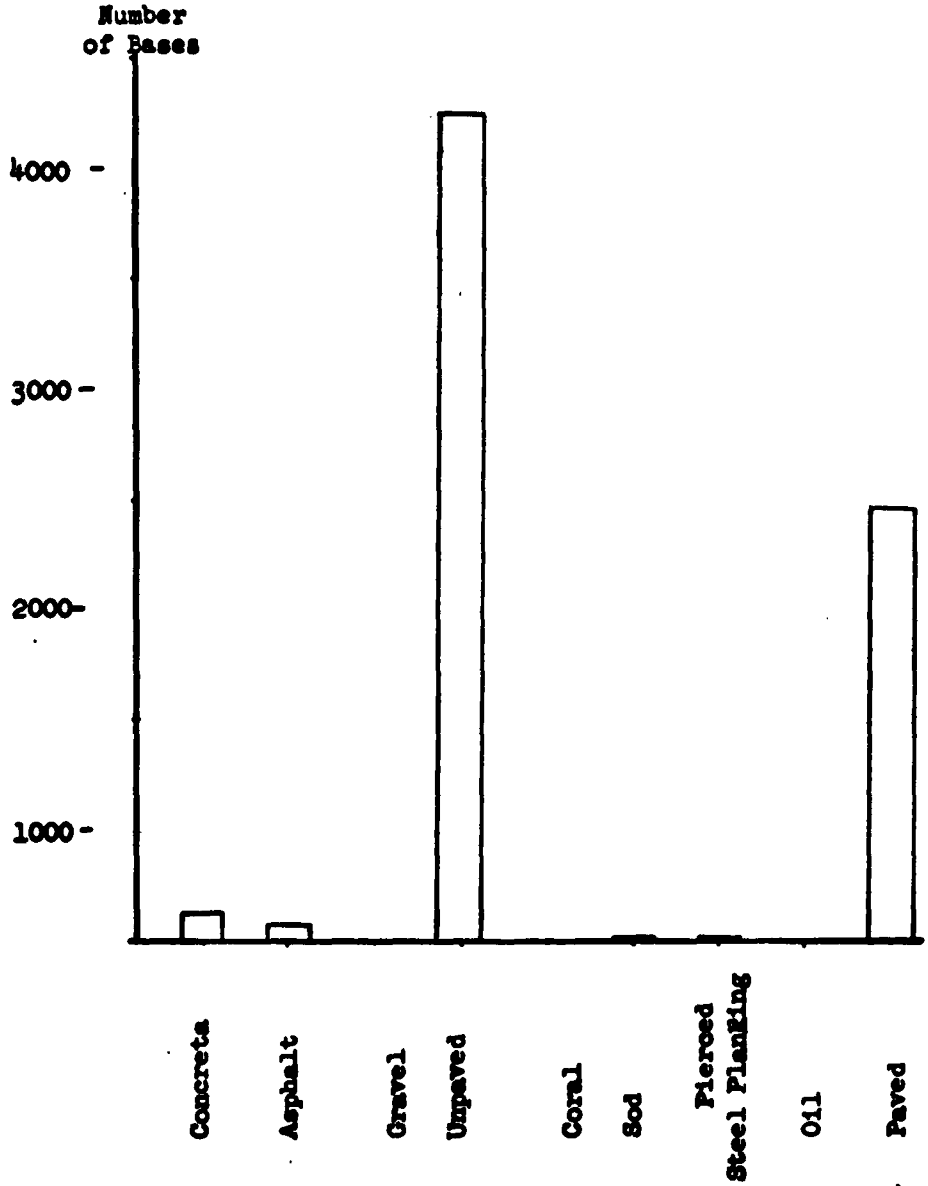


Figure 14

ACCESSIBILITY TO ROAD
U.S. Z.I.

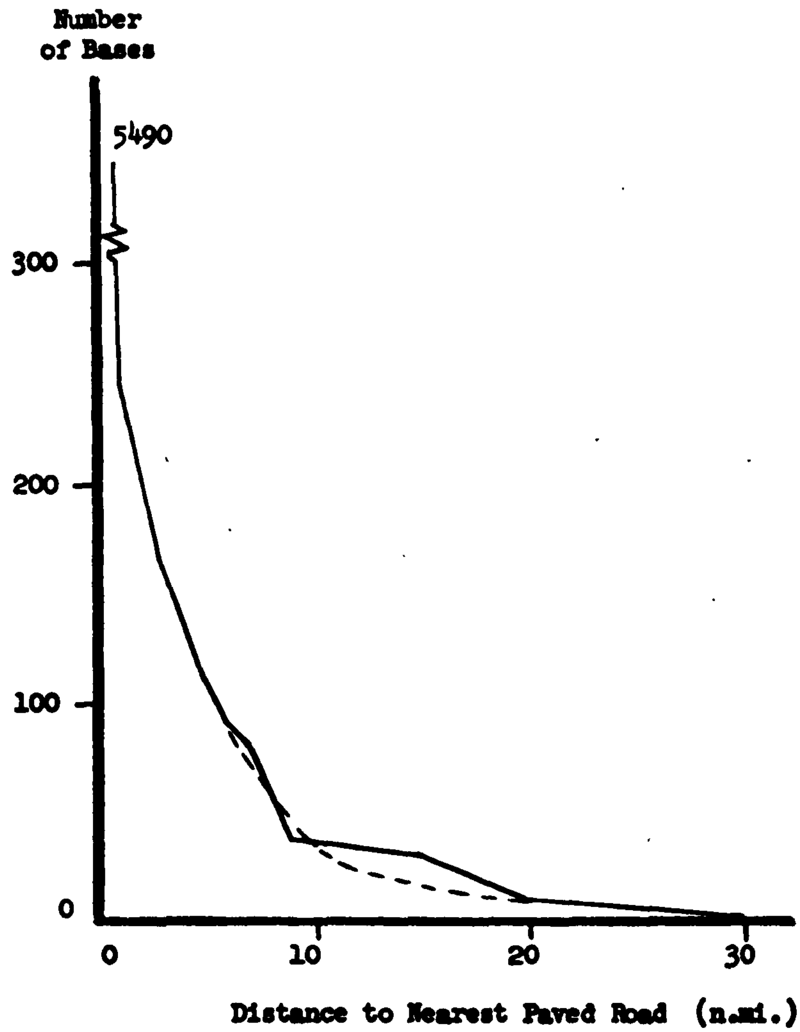


Figure 15a

ACCESSIBILITY TO ROAD

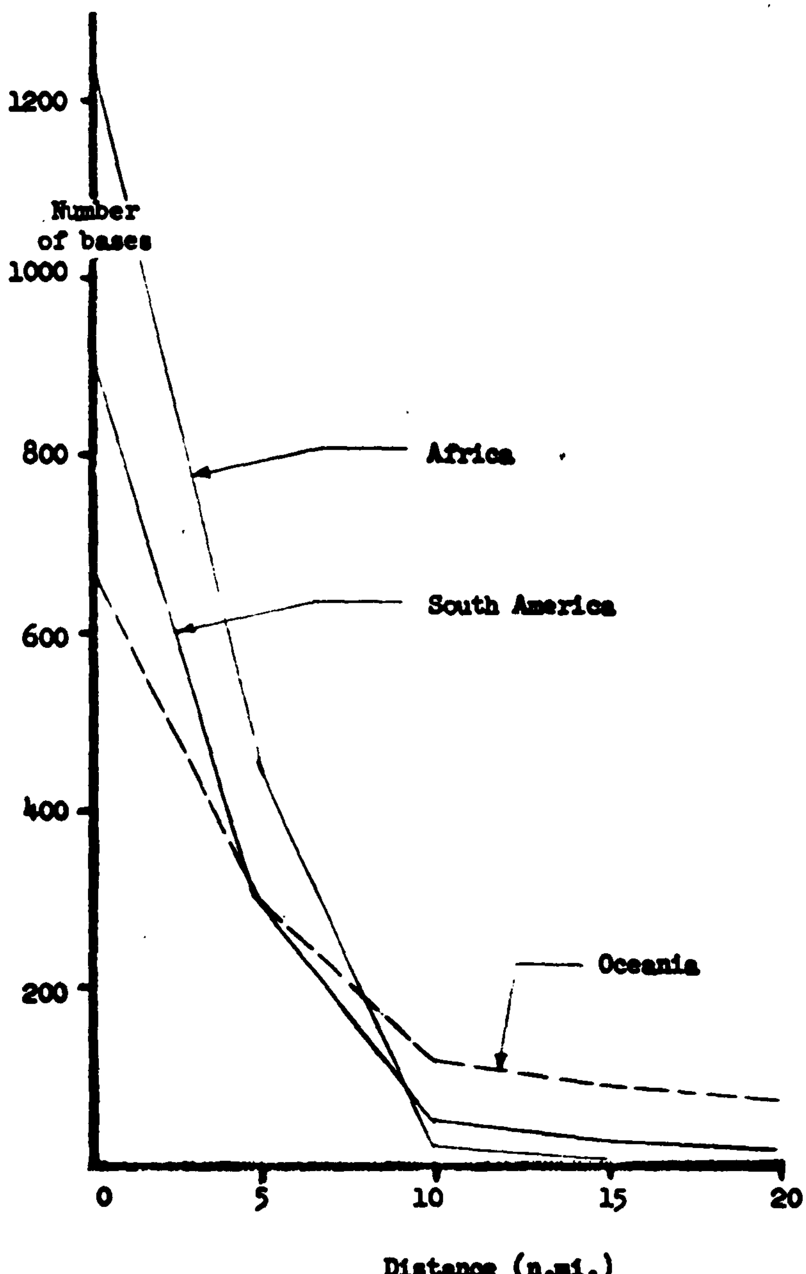


Figure 15b

ACCESSIBILITY TO ROAD

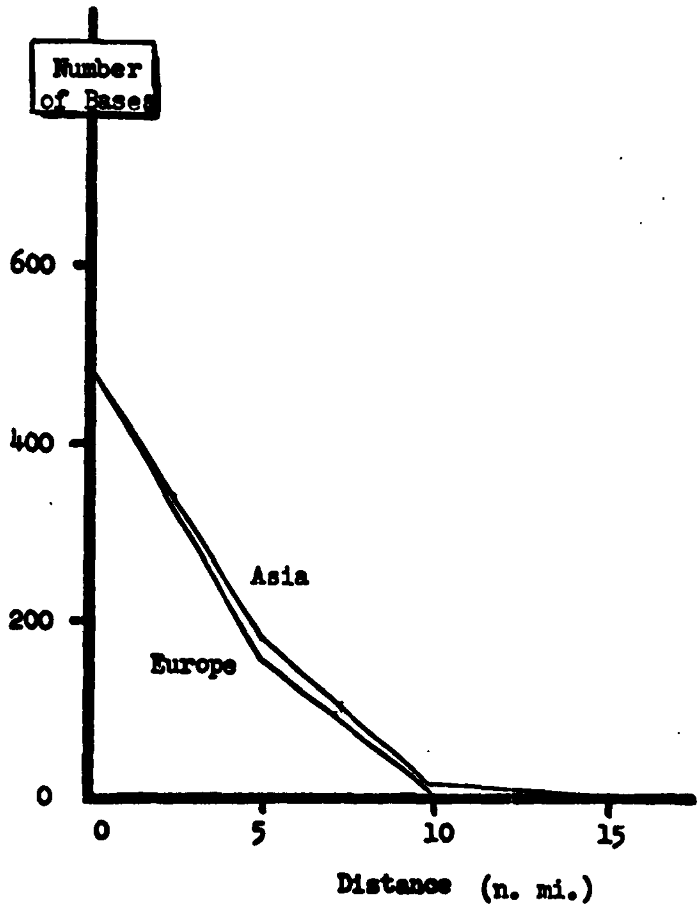


Figure 15c

DISTANCE TO RAILROAD

U.S. Z.I.

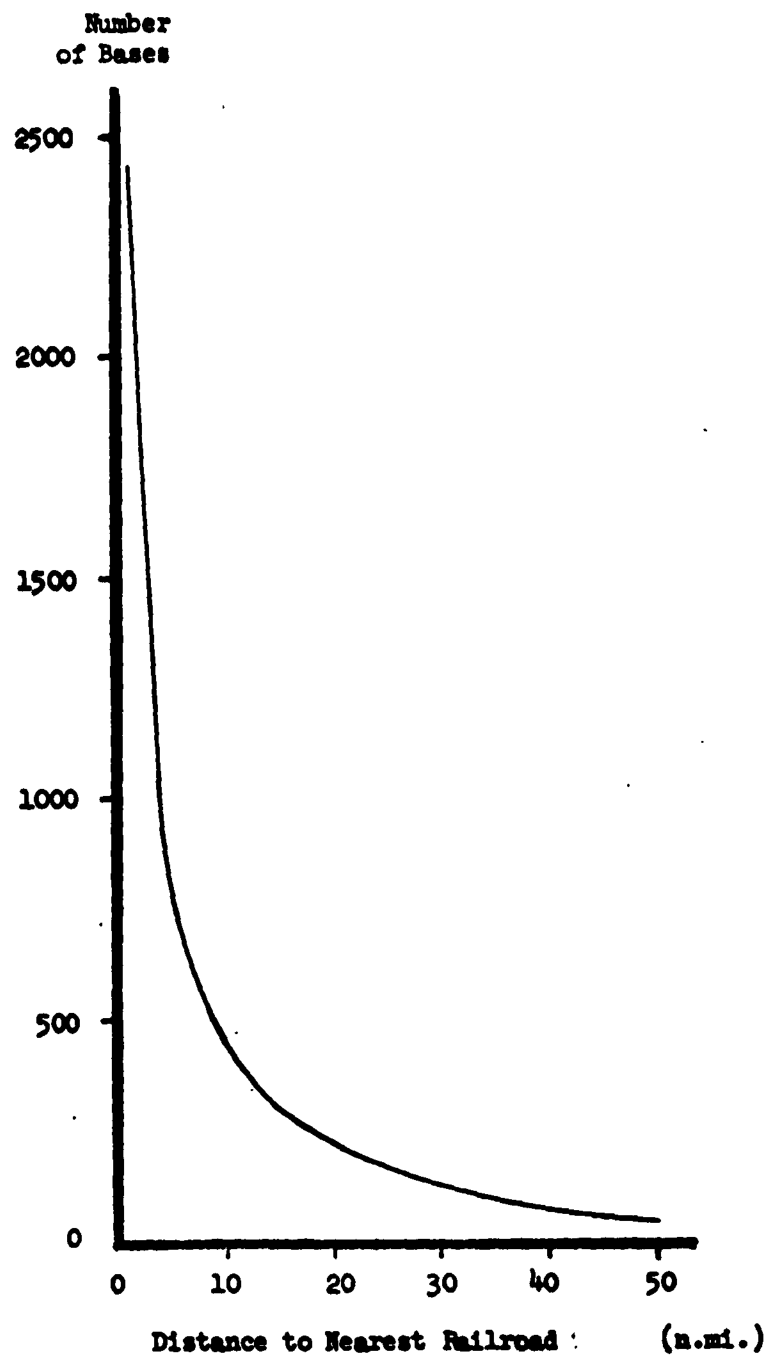


Figure 16

ACCESSIBILITY TO PRIMARY BASE

U.S. Z.I.

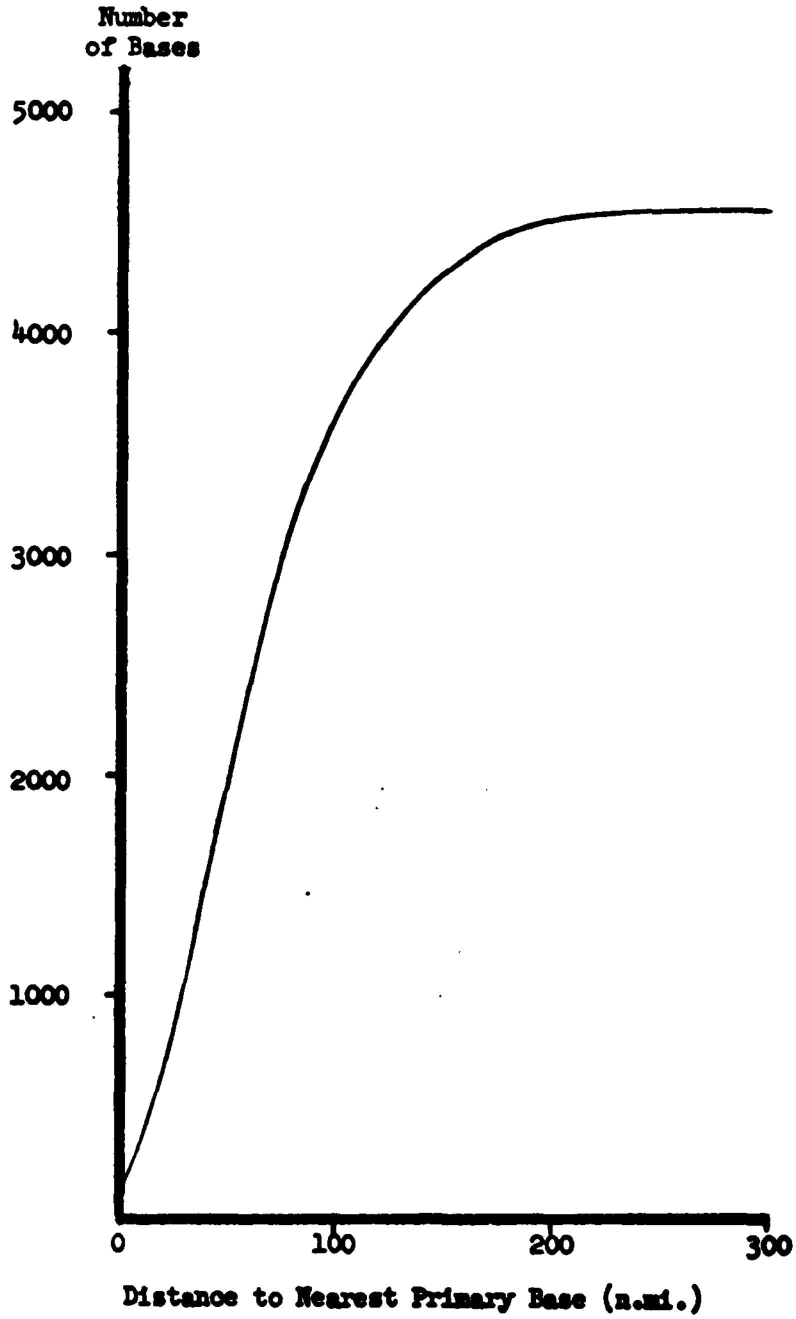
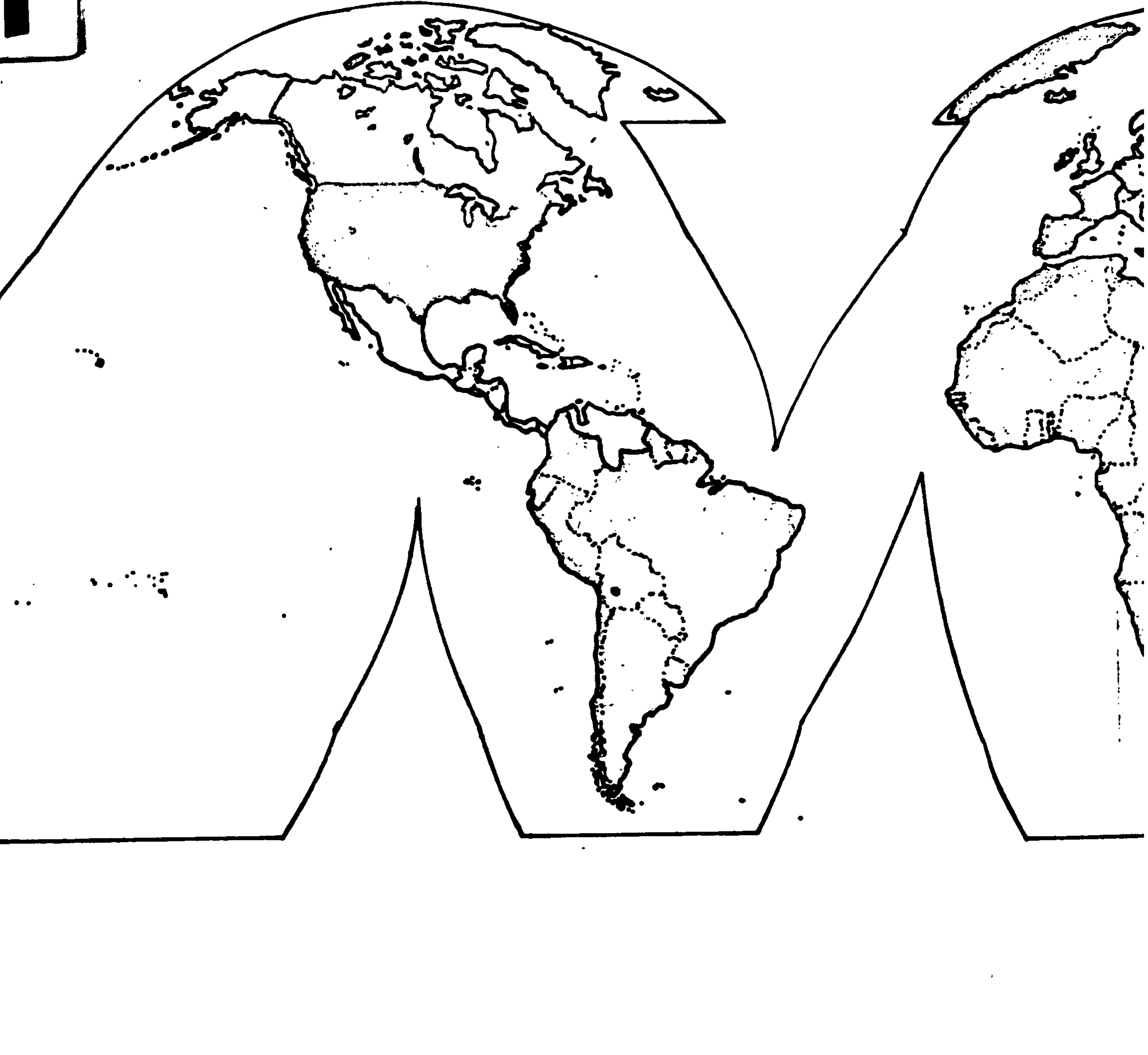


Figure 17

TABLE IV

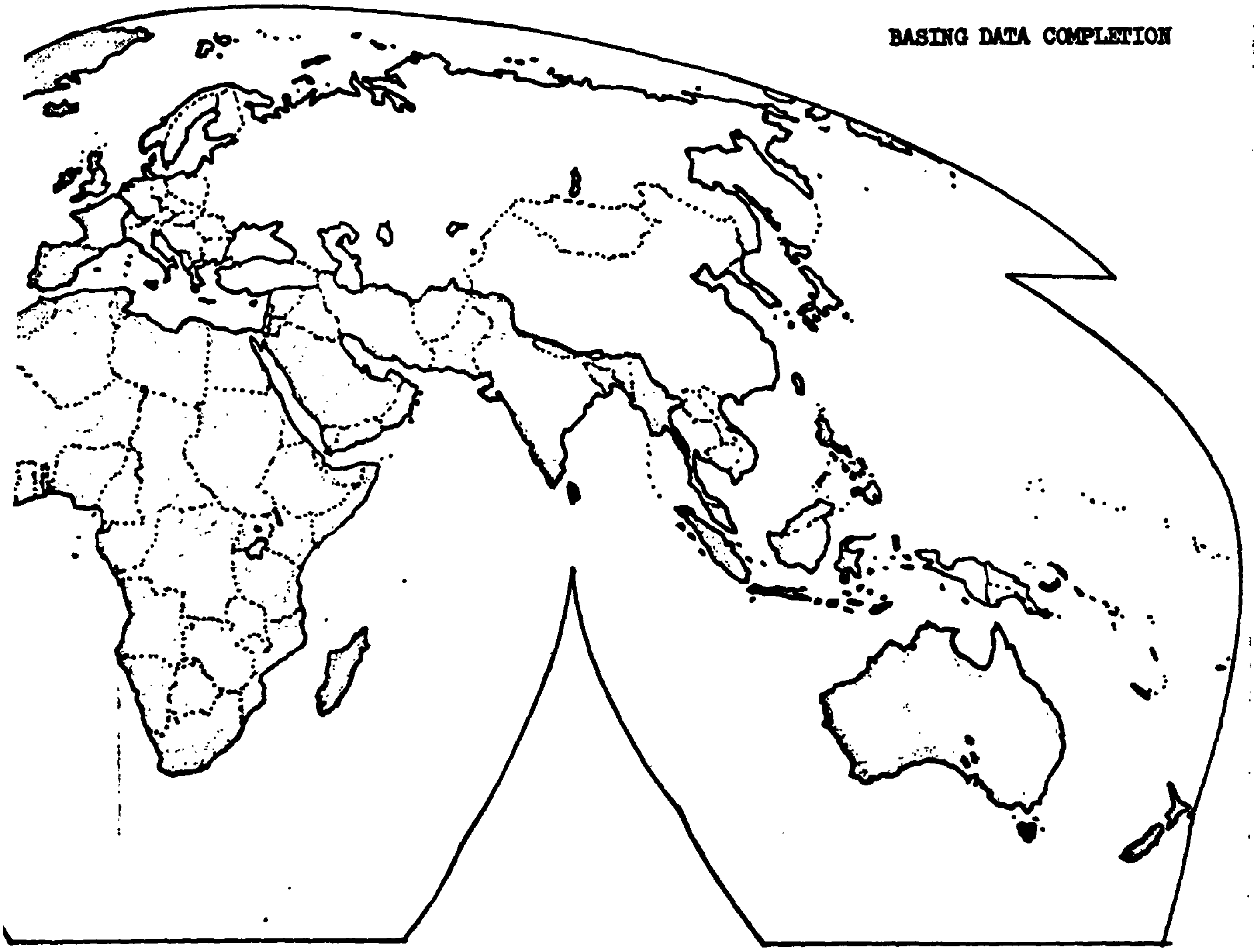
DISTRIBUTION OF RUNWAYS BY STATE

STATE	Total Number	Number Military	Number Paved	Number 25000' Length	Number 27000' Length	Number 210,000' Length
Alabama	86	6	49	11	5	1
Arizona	144	26	42	42	12	8
Arkansas	94	4	40	15	4	2
California	381	42	249	100	44	17
Colorado	85	3	24	34	7	2
Connecticut	25	1	11	3	1	0
Delaware	14	1	3	3	2	0
Florida	166	32	162	70	25	6
Georgia	127	11	58	33	12	5
Idaho	154	2	20	14	3	1
Illinois	184	5	68	14	5	1
Indiana	131	2	45	12	4	1
Iowa	172	0	31	9	2	0
Kansas	205	6	56	24	12	3
Kentucky	43	5	24	10	3	1
Louisiana	100	5	30	15	6	2
Maine	56	3	25	10	4	2
Maryland	58	9	25	14	5	1
Massachusetts	68	6	34	14	6	2
Michigan	211	8	70	29	9	5
Minnesota	159	0	35	7	2	1
Mississippi	85	5	37	14	6	1
Missouri	142	3	53	12	7	3
Montana	143	2	32	17	8	2
Nebraska	160	3	35	16	10	1
Nevada	52	6	23	25	9	3
New Hampshire	27	1	14	5	2	1
New Jersey	68	2	20	8	3	2
New Mexico	73	5	39	36	14	5
New York	217	15	55	33	14	4
North Carolina	114	13	42	19	7	1
North Dakota	163	2	14	10	3	2
Ohio	256	6	66	24	12	4
Washington	152	10	47	32	12	5
West Virginia	46	2	14	6	1	0
Wisconsin	147	3	41	8	3	0
Wyoming	55	0	22	23	4	1



2

BASING DATA COMPLETION



COMPLETED

TO BE UPDATED

Figure 18

RUNWAY DISTRIBUTION - GENERAL

MILITARY AND CIVILIAN RUNWAYS

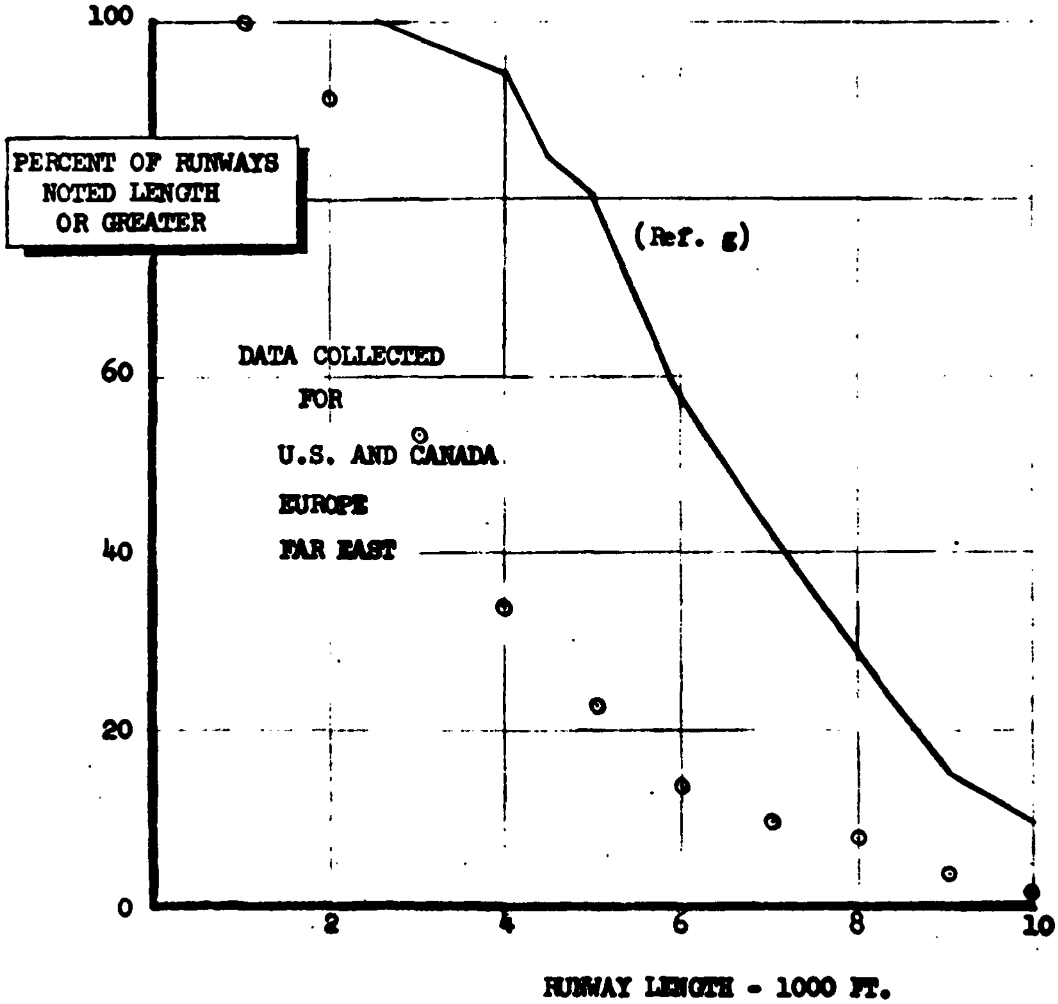


Figure 19

RUNWAY DISTRIBUTION - EUROPE

MILITARY AND CIVILIAN RUNWAYS

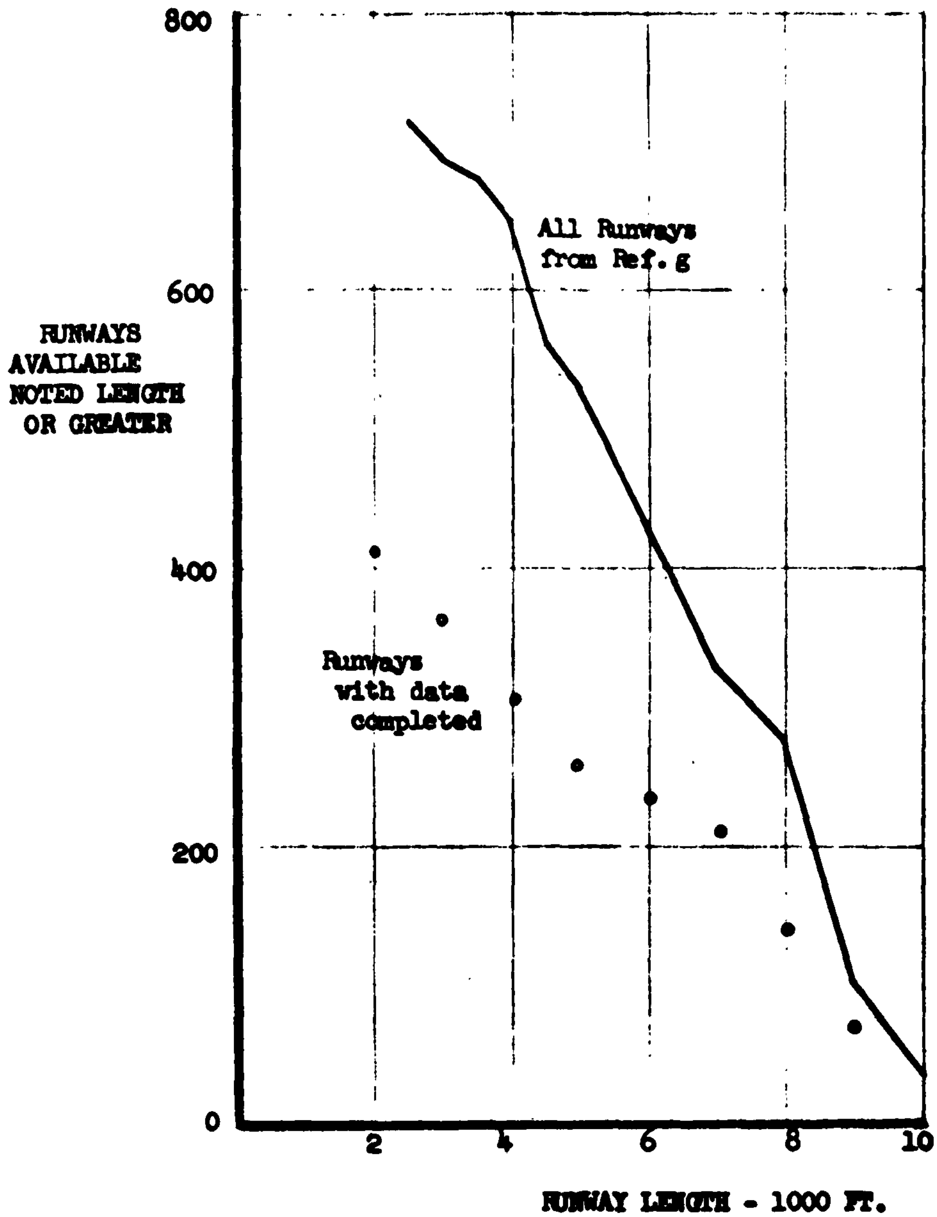


Figure 20

DISTRIBUTION OF AIRBASES - EUROPE

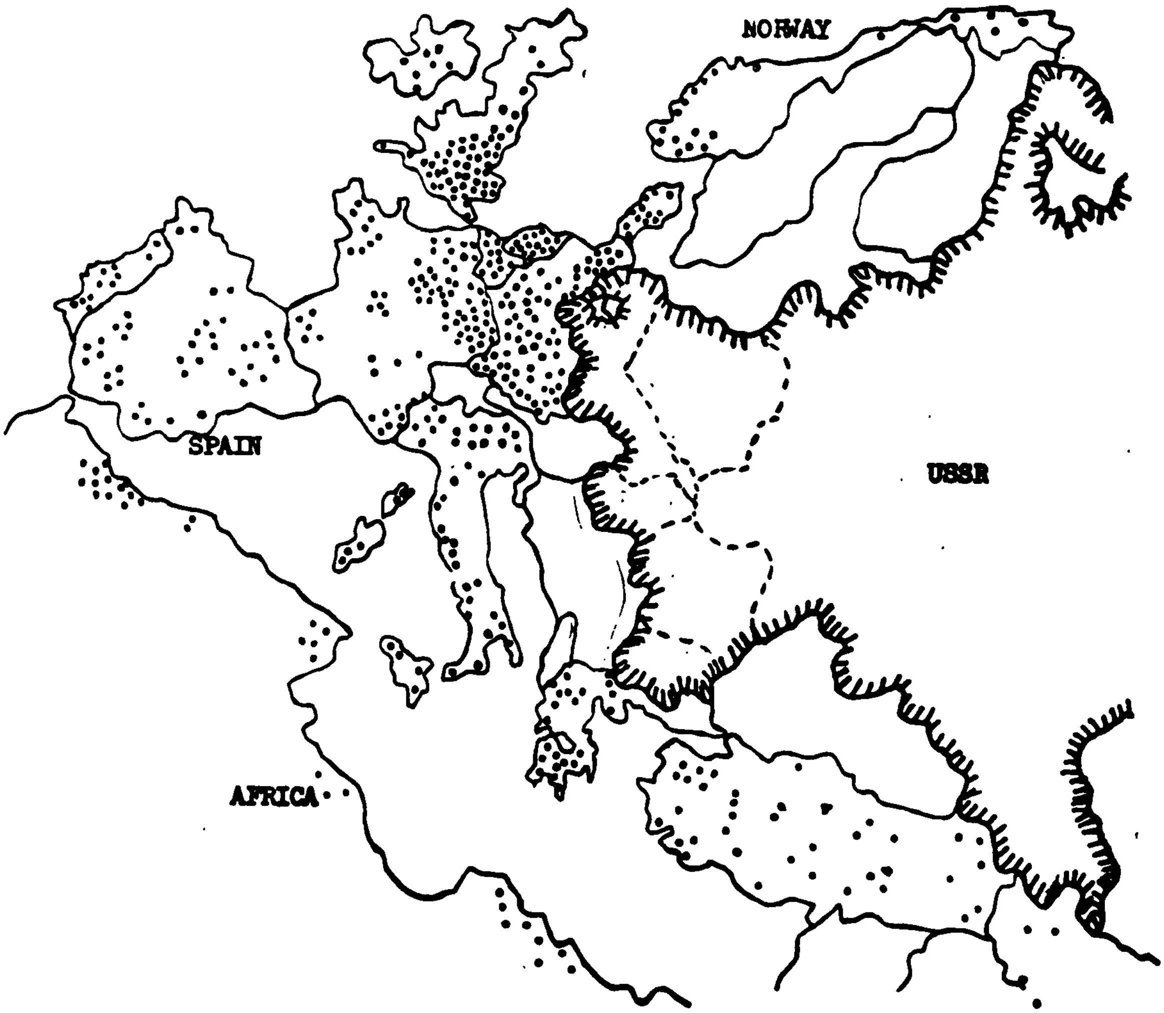


Figure 21

DISTRIBUTION OF AIRBASES - FAR EAST

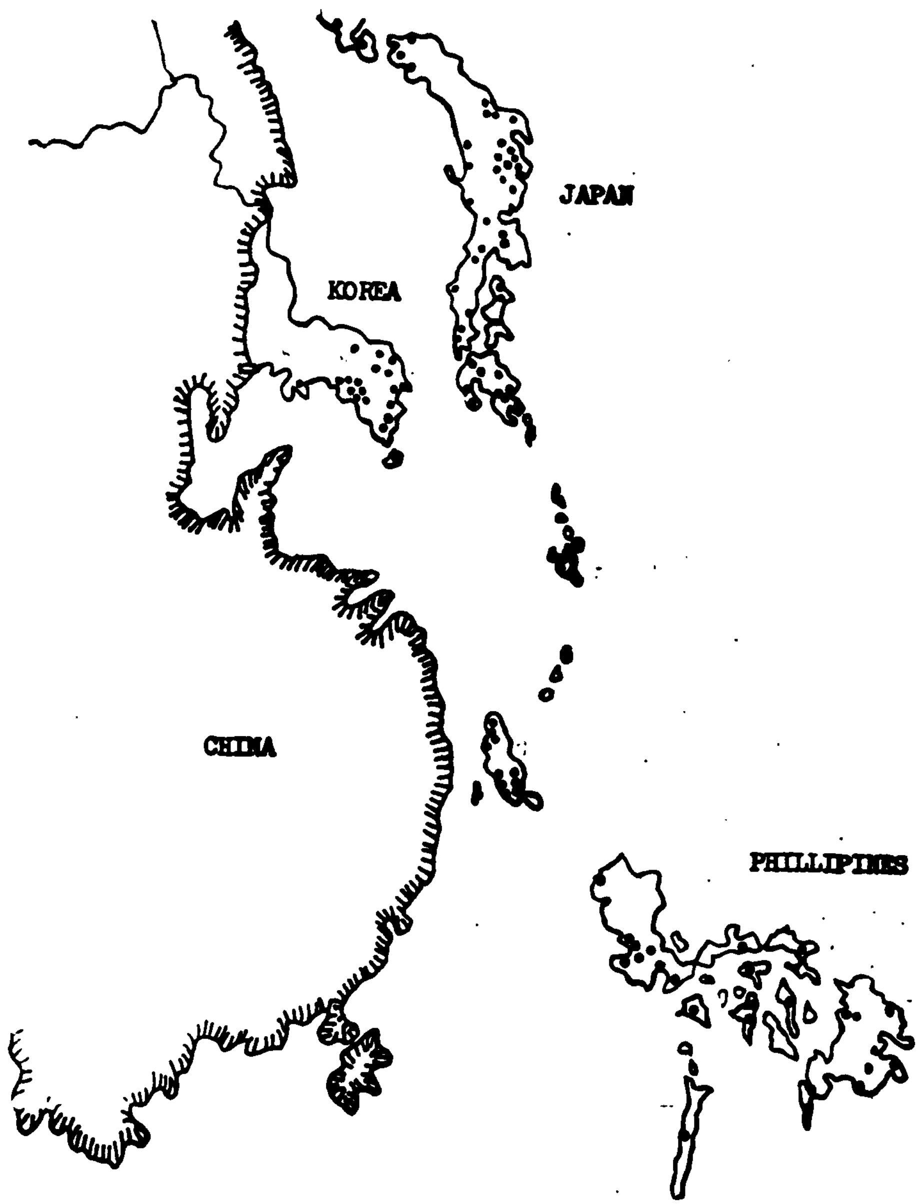


Figure 22

AIRPORTS IN AFRICA

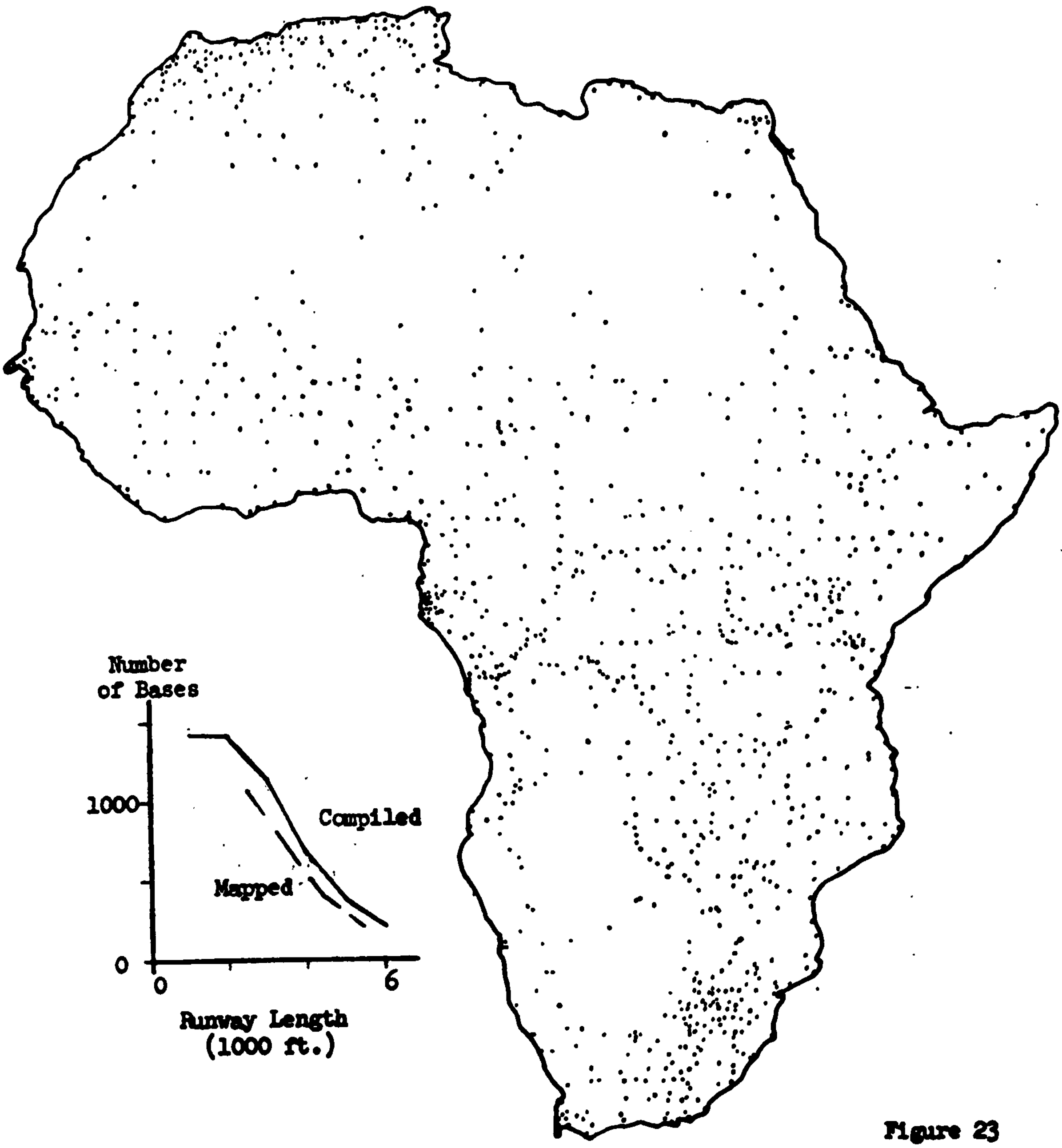
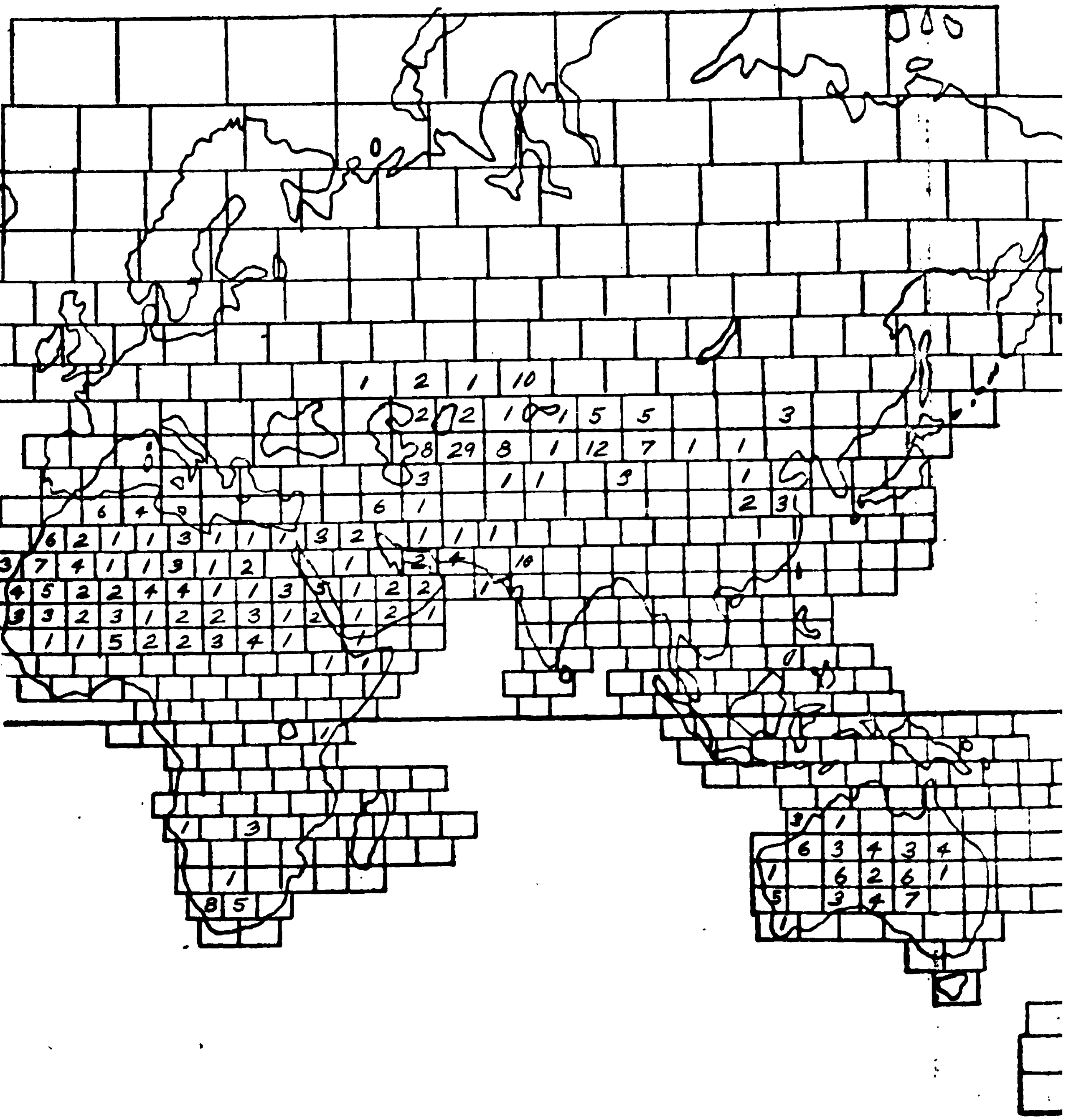


Figure 23


CANADA


ICE-FREE SITES
IN THE ARCTIC
GREENLAND
2
HUDSON BAY
LABRADOR

Figure 24



1 2 1 10 1
2 2 2 1 10 1 5 5 3
8 29 8 1 12 7 1 1
3 1 1 3 1
6 4 6 1 2 3
6 2 1 1 3 1 1 1 3 2 1 1 1
3 7 4 1 1 3 1 2 1 2 4 10
4 5 2 2 4 4 1 1 3 5 1 2 2 1
3 3 2 3 1 2 2 3 1 2 1 2 1
1 1 5 2 2 3 4 1 1
1 1 0
1
1 3
1
8 5
3 1
6 3 4 3 4
1 6 2 6 1
5 3 4 7
1

GLOBAL DISTRIBUTION OF

NATURAL LANDING AREAS

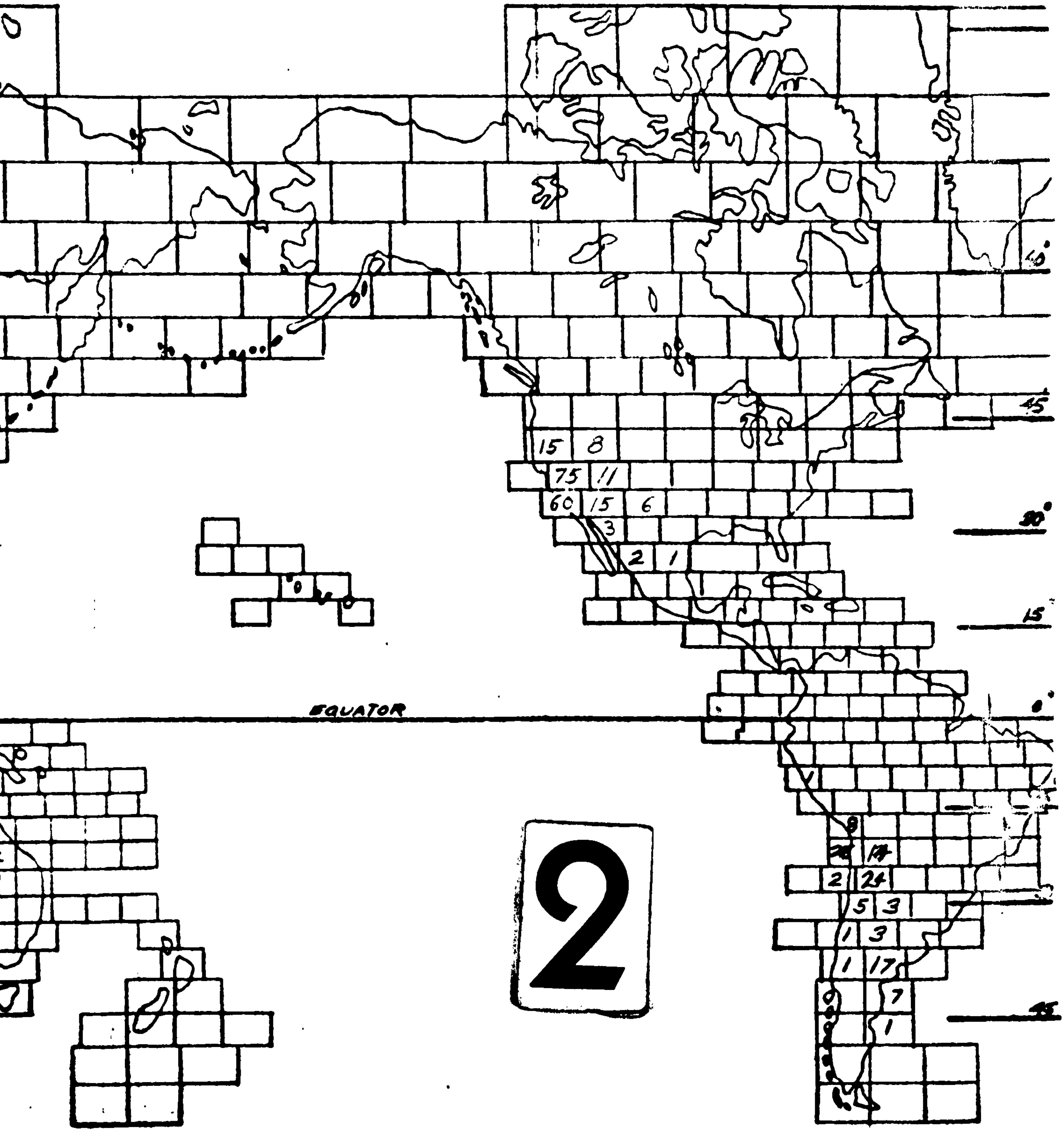


Figure 25

STATES IN WHICH DRY LAKES ARE FOUND

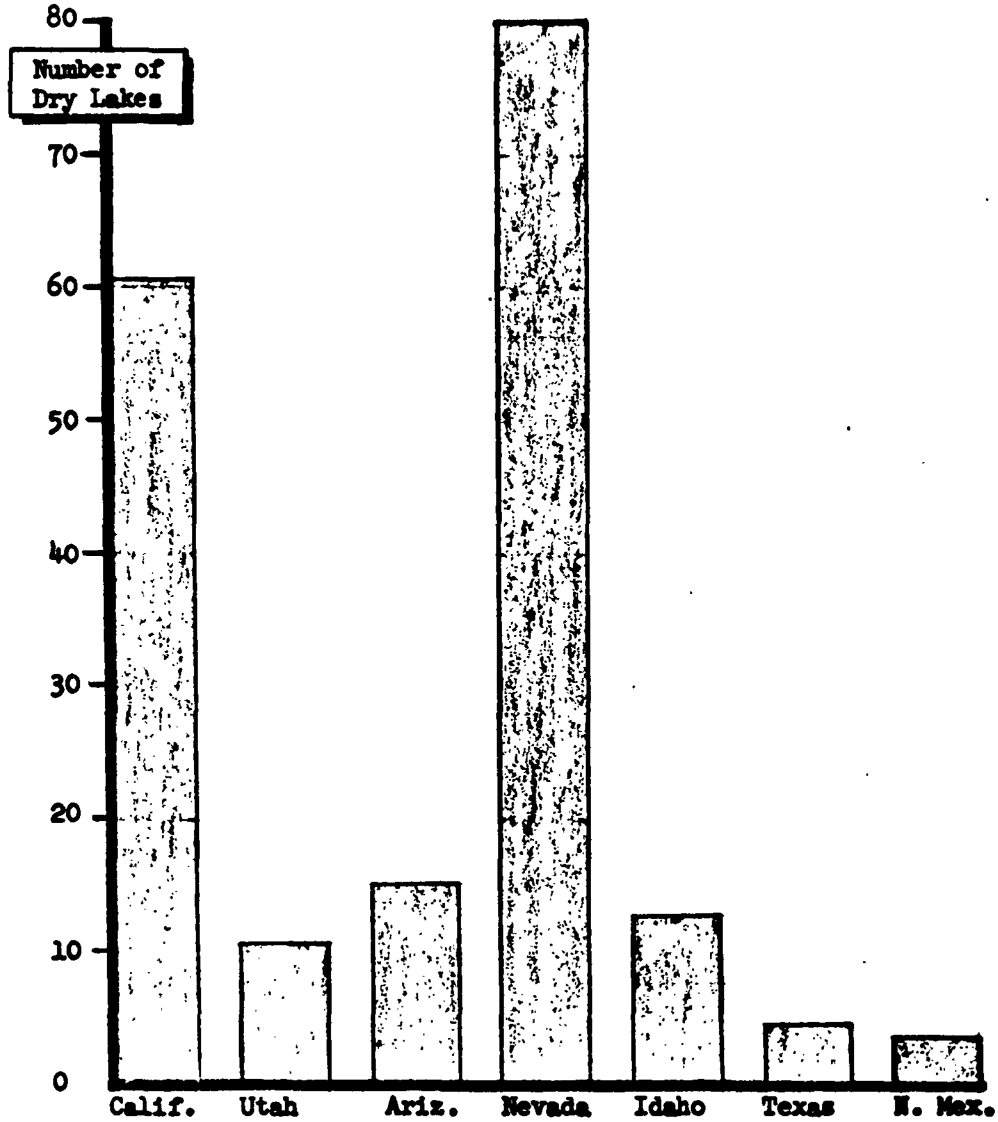


Figure 26

LENGTH OF

DRY LAKE MAJOR AXES

U.S. Z.I.

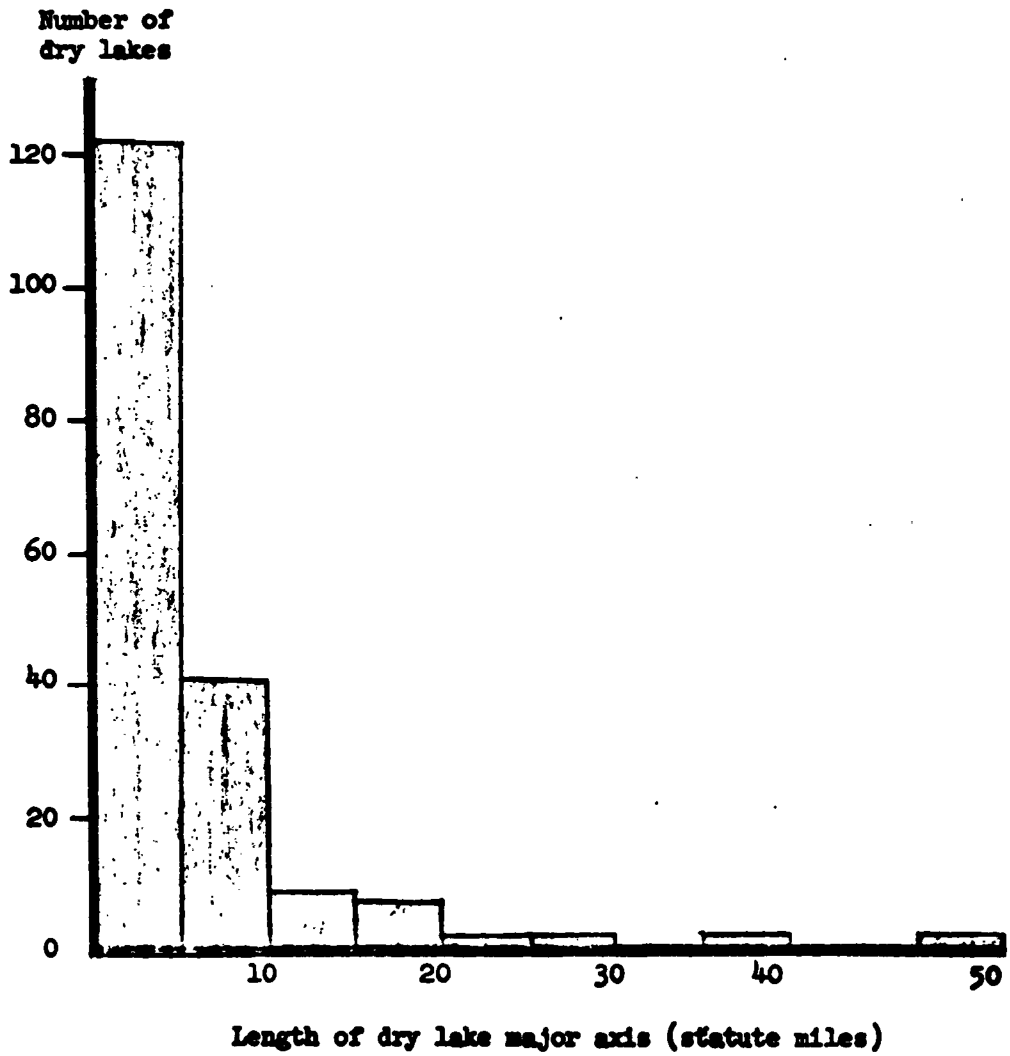


Figure 27

ACCESSIBILITY OF DRY LAKES TO
RAILROADS AND HIGHWAYS

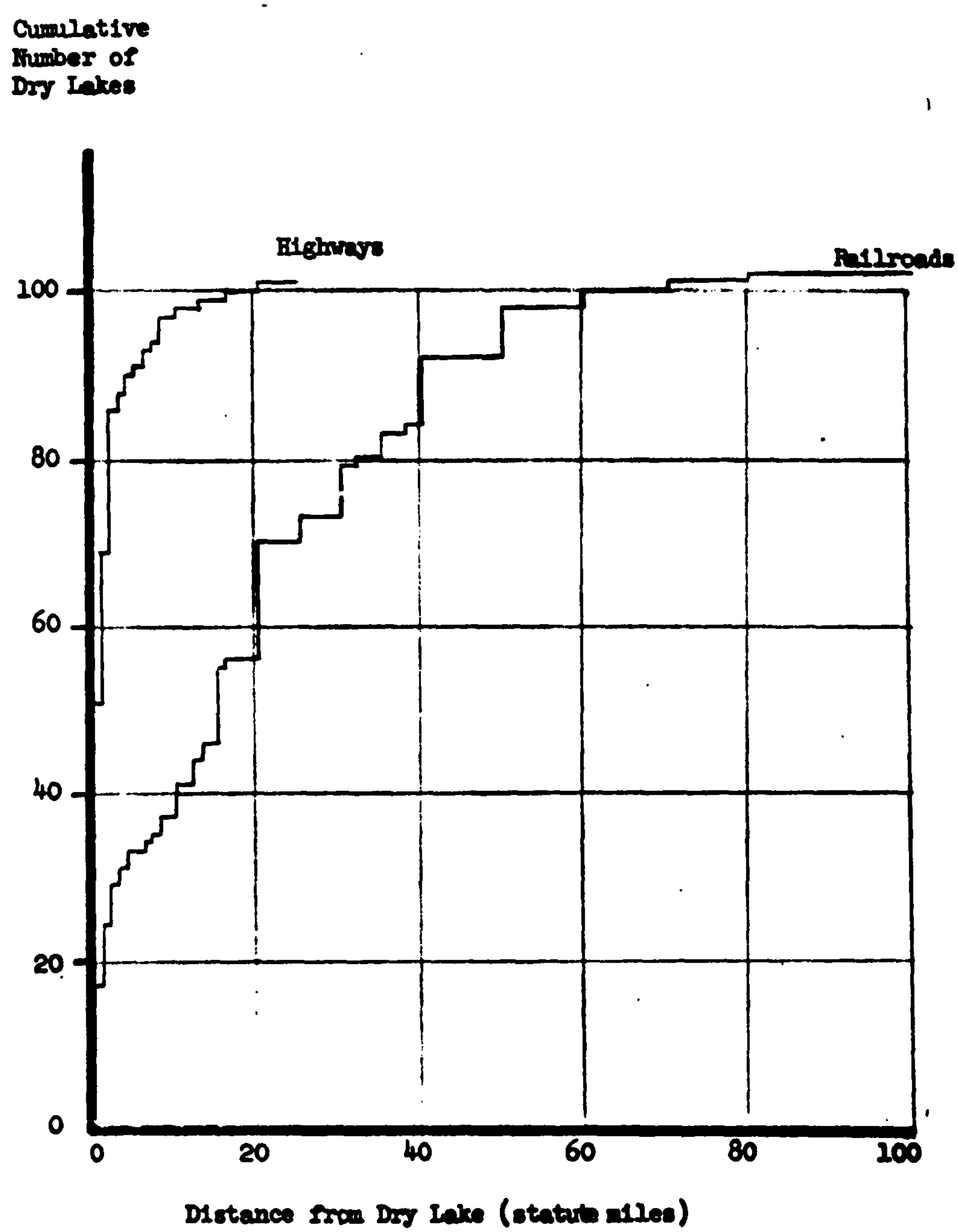


Figure 28

ACCESSIBILITY TO THE NEAREST TOWN

U.S.

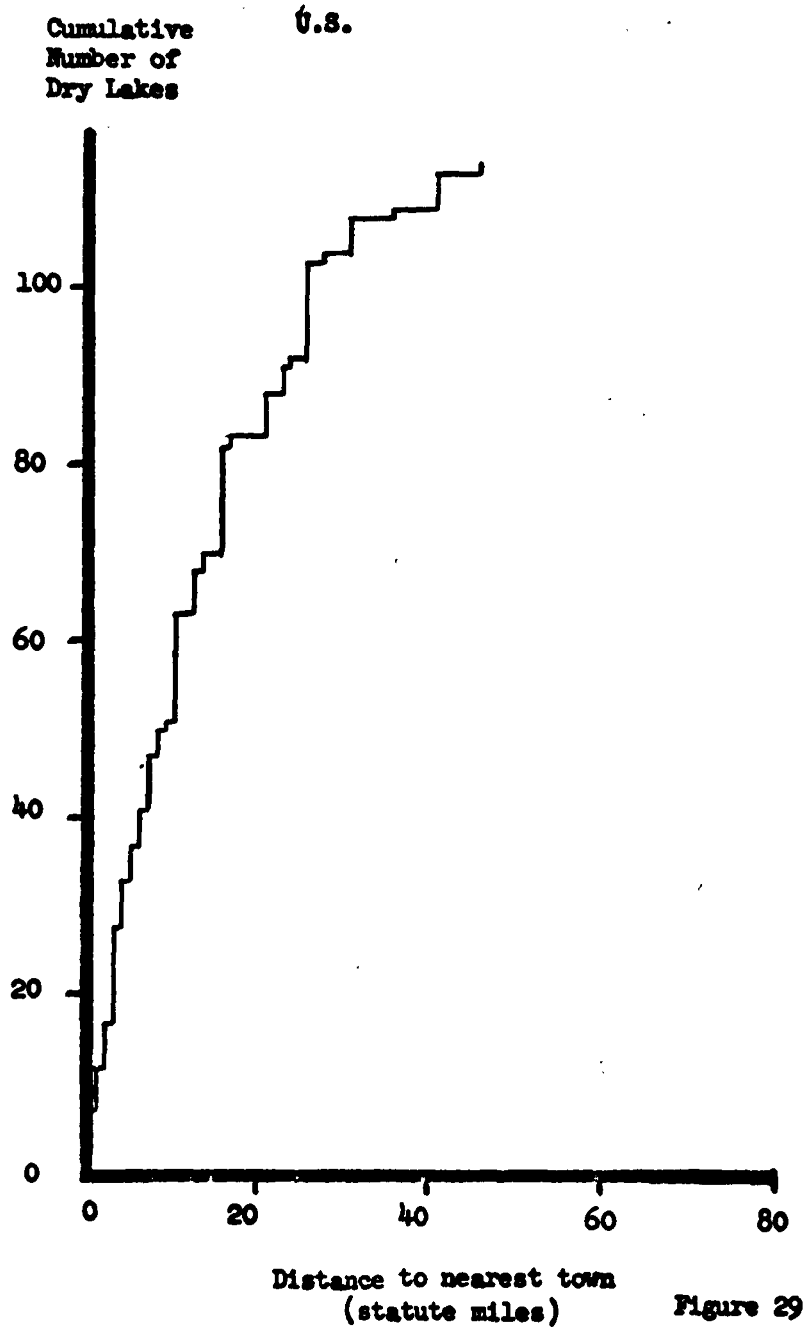


Figure 29

ALTITUDE OF DRY LAKES

U.S.

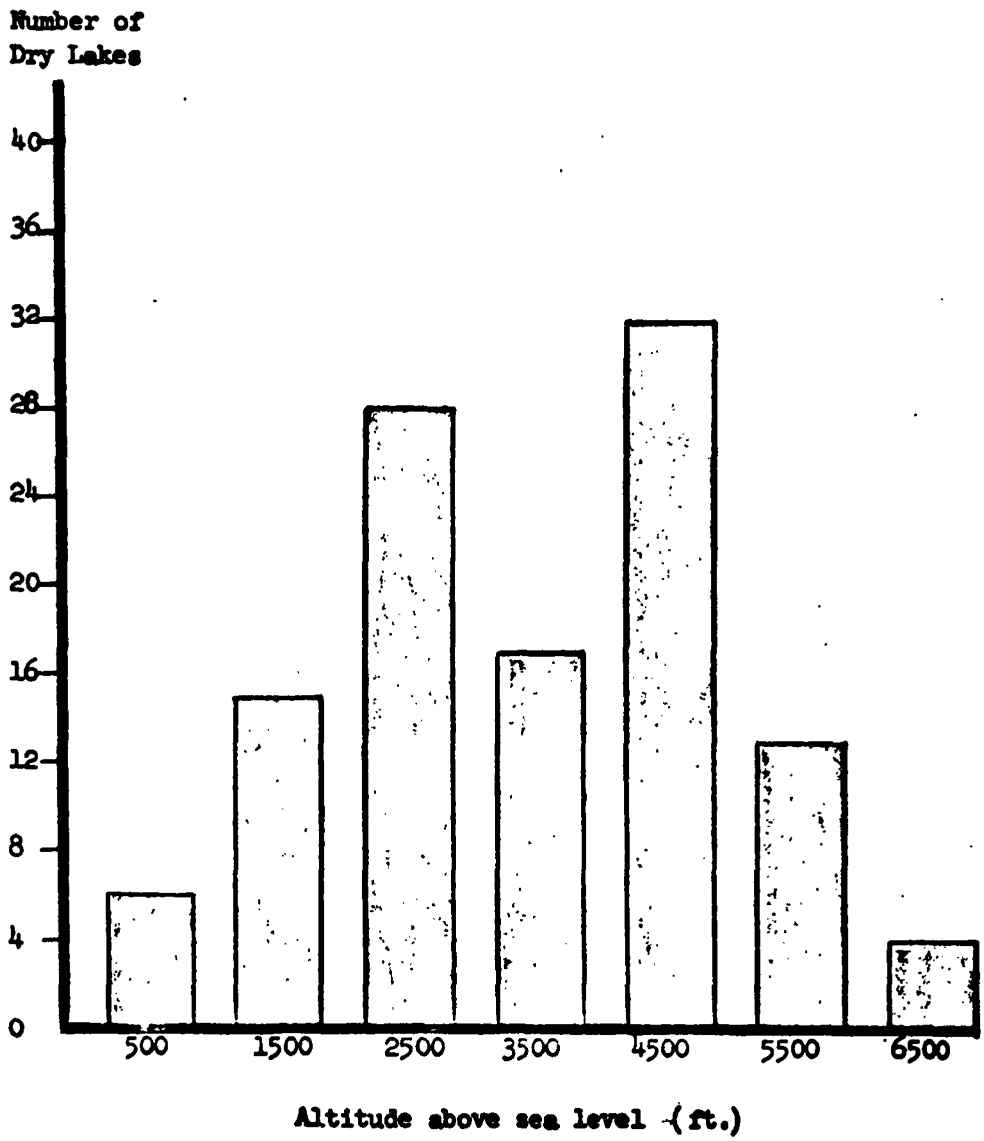


Figure 30

ALTITUDE OF DRY LAKES

GLOBAL

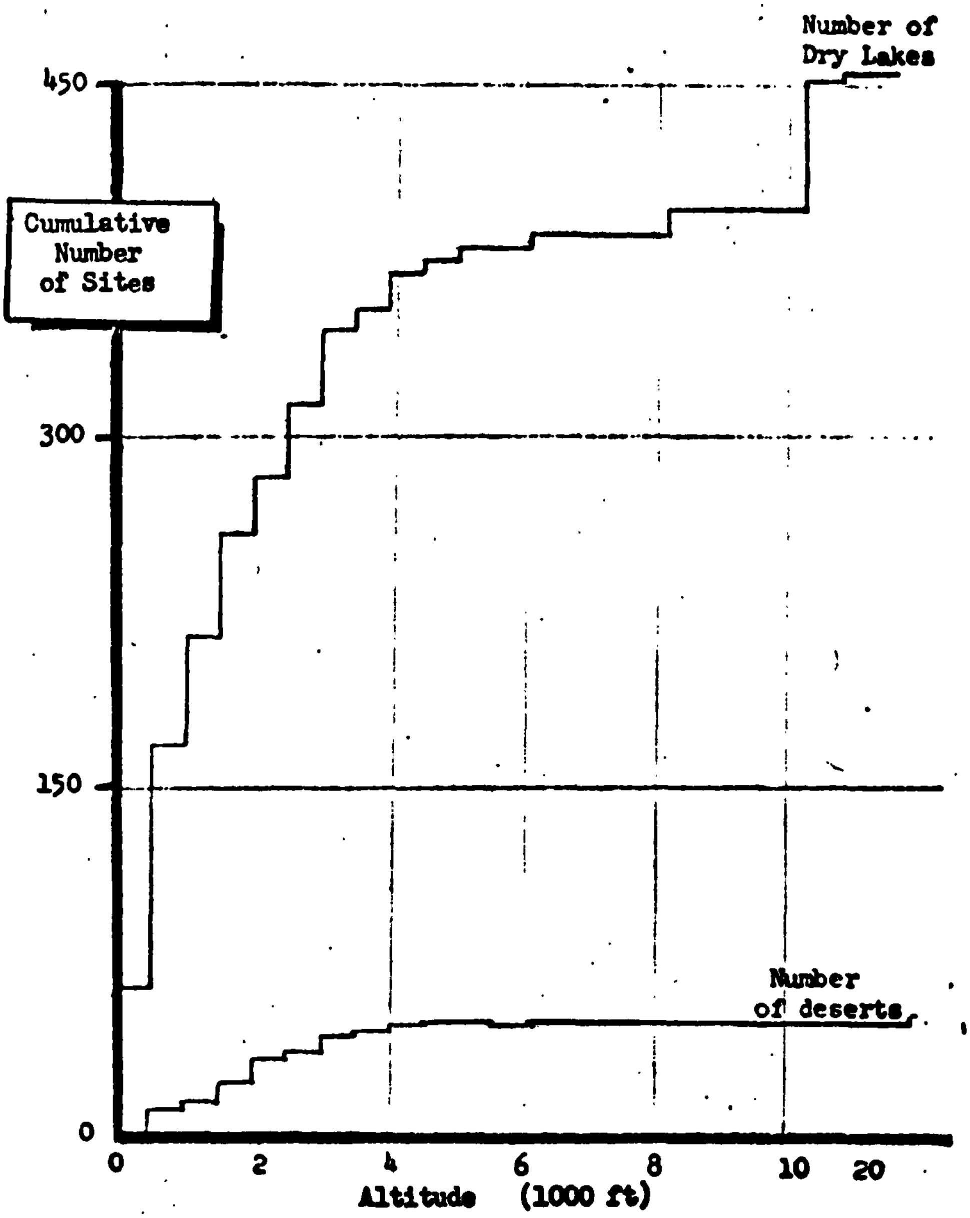


Figure 31

SECTION III

NATURAL ENVIRONMENT

CLIMATIC DATA

The AN/TSQ-47 must operate in a wide range of climatic environments which significantly affect the design and performance of the system. The material in this section defines the conditions which the AN/TSQ-47 will encounter in its expected deployments.

SELECTION OF DATA

Rather than obtain exhaustive data on weather at each airbase, a sampling of weather data is handled in a statistical manner. The earth was divided into one hundred and fifty nine climatic areas (Figure 32) and a representative weather station was chosen in each. The extent and location of each area was determined on the basis of latitude, local terrain, continentality, average rainfall, and vegetation. It is realized that these areas are only first approximations to homogenous climatic areas but they will indicate the extremes of climate that will be encountered in world-wide deployment.

Climatic parameters to be studies were selected by examining the military specifications for the AN/TSQ-47 and similar systems. Additional information, such as air conditioning design data, which was considered important to the proper design and functioning of systems was also included. The pertinent specifications are given in Table V. The Climatic Center, USAF, is providing NAA with the following parameters for each of the weather areas.

1. Probability of occurrence of annual extreme one-minute gusts greater than 60 knots, greater than 80 knots.

2. Probability of occurrence of annual peak gust greater than 100 knots, greater than 120 knots, greater than 150 knots.

3. Mean monthly and annual precipitation amounts and the average number of days/months that specified amounts are equaled or exceeded.

4. Risk of an annual occurrence of precipitation intensity of 1.0, 1.5, and 2.0 in/hr for a one-hour duration.

5. Percent of time that relative humidity equals or exceeds 90% during January, April, July, October.

6. The dry-bulb temperature which is equalled or exceeded 97½% of the time during the three coldest consecutive months.

7. The dry-bulb temperature which is equalled or exceeded 2½% of the time and the wet-bulb temperature which is equalled or exceeded 5% of the time during the four consecutive warmest months of the year.

8. Frequencies of temperatures greater than 110° F, 115° F, and 120° F during the warmest month.

9. Frequencies of temperatures below -20° F, -40° F, -60° F, -80° F during the coldest month of the year.

10. Frequencies of VFR, IFR, and below-IFR conditions.

All of the data except VFR, IFR, and below IFR information is included in Reference (k). While each of the continents exhibits much in its climatic arrangement in harmony with the general world pattern and can be represented adequately with the one-hundred-and-fifty-nine areas, there are numerous departures from the expected arrangement or intensity (See Table VI). These departures are the results of regional or local controls, such as geographical uniquenesses in the land areas themselves, (shape, size, terrain height and alignment, trend of coastline in relation to air flow, etc.) and/or features of atmospheric or oceanic circulations.

Static pressure and magnetic anomalies are not included in this report. Pressure can be described in terms of altitude which is given for each airbase and variance due to climatic variations is insignificant in comparison. Magnetic anomalies have been well mapped and are more significant to operation than design of the AN/TSQ-47.

PRESENTATION OF DATA

Information which can be obtained from analysis of present data is presented in Figures 33 to 38.

Figure 33 presents the number of areas attaining or exceeding a given temperature a given percent of the time. As will be noted, only six of the climatic areas attain or exceed 120° F. However, this figure represents ambient air temperature. Men and equipment may experience temperatures thirty to forty degrees higher than this under some conditions.

Figure 34 presents the number of areas equalling or exceeding a given precipitation in one year. Less than twenty areas exceed one-hundred inches per year but, as seen in Figure 35, instantaneous rates do exceed two inches per hour in the United States with a degree of regularity. This is especially true in the southern coastal states during thunderstorms. Figure 36 presents the number of areas having at least 90% relative humidity a given percent of the dampest months. Humidity dependent agents such as fungus and corrosion can be seen to be almost a universal problem.

The significance of these data will be evaluated in the second phase of this study. Because of the small sampling these data should not be used in their present form for design decisions.

DETERIORATION FACTORS

As a conjunct of specific climatic areas there are certain deteriorative agents which can be extremely hazardous to a system. Such agents would be fungus, sand, dust, aerosols, and electrochemical corrosion.

The group of organisms which have received the most attention in recent years with respect to deterioration problems are the fungi. A good deal of this research interest arose from the widespread fungal attack on equipment used by the Armed Forces in World War II. Although first glance would suggest that mere removal of the unsightly growths might satisfactorily recondition items so affected, it soon became apparent that the damage was much more deep-seated.

The geographical distribution of the fungi is a subject about which, in the early years of World War II, there was widespread misunderstanding among deterioration workers. At that time it was quite commonly assumed, and sometimes rather definitely stated, that the numerous micro-biological deterioration problems encountered in the humid, tropical combat areas were in some way associated with the presence in these regions of a special population of tropical fungi. Actually, although conditions for most types of fungus growth are at an optimum in humid, tropical areas, there was at the time exceedingly little evidence to suggest that the population of nonparasitic fungi prevalent in the combat zones was much different from that found in the continental United States. A considerable body of information was available to the contrary. Subsequent isolation and identification of large numbers of fungi from tropically exposed items by members of the United States Army Quartermaster Corps failed to disclose any common genera which could be isolated as characteristically tropical or largely limited to tropical areas. The fabric-and-paper attacking Memmoniella, which does actually appear to be primarily tropical in distribution, hardly represents a valid exception to this generalization, since it is so very closely related in structure and in physiology to Stachybotrys, a common form in temperate climates. No type of deteriorative potentiality has yet been proven to be associated with isolates from tropical areas, which is not possessed in equal or greater degree by fungi from temperate zones.

The AN/TSQ-47 must be protected from fungal attack in all temperate and tropical climates. Stress should be placed on the necessity of properly conditioning the environment which would be encountered by the system. Proper air conditioning will offer a large degree of internal protection during operation but storage can present a significant corrosion hazard. It has been suggested that during storage the system be placed in a warehouse with controlled environment if possible. A relative humidity of 30% or less has been indicated as necessary to eliminate both fungus and electro-chemical corrosion.

In most locations dust, sand, and aerosols do not play any great part in the difficulties associated with military equipment; however, in desert and shore conditions, sand may badly pit exposed surfaces and accumulated dust may cause arcing, sticking, and burning out of electrical equipment. Exposure to aerosols of other sorts may cause softening, embrittlement, absorption, corrosion, and electrical shorting. Filtering must be effective against a wide range of particle sizes to protect against dust, sand, and aerosols. (Figures 37 and 38)

The above observations in relation to deterioration problems resulted from a conference at the Prevention of Deterioration Center (Reference (1)). This organization is well equipped for analysis of specific design problems and is recommended as an appropriate advisory agency for assessing the adequacy of the specific design solutions being incorporated by the AN/TSQ-47 prime contractor.

TABLE V

SPECIFICATIONS FOR AN/TSQ-47

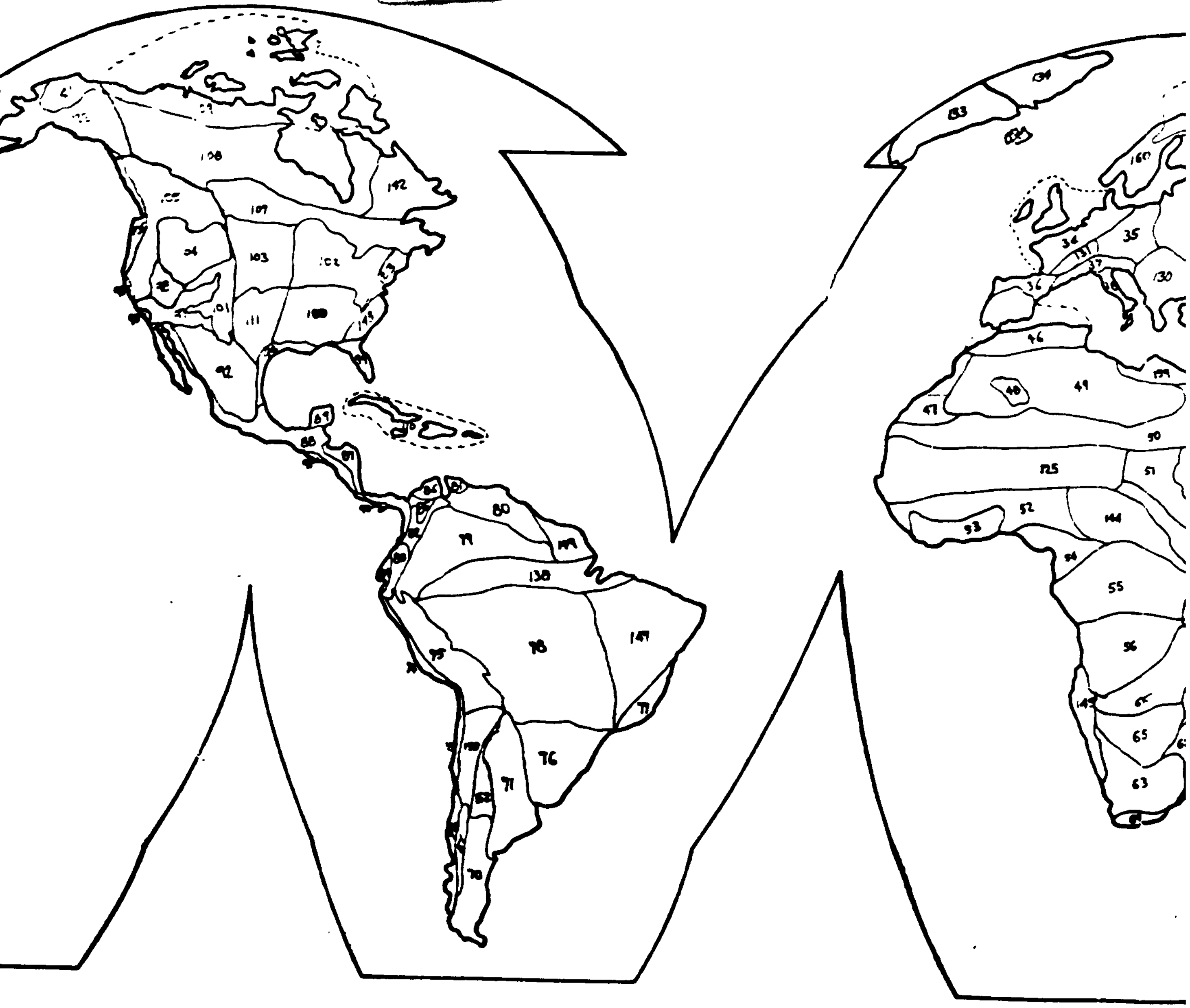
	No Degradation	No Structural Damage
Low Temperature	-40°F	-180°F *
High Temperature	125°F	160°F *
Rainfall	Two in/hr	-----------
Snowfall	One in/hr windblown	-----------
Wind	52 n. mi.	100 n. mi.
Relative Humidity	95%	-----------
Icing	One inch	-----------
Altitude	10,000 ft. **	-----------

* in storage

** The AN/TPN-14 shall operate up to 6000 ft. in altitude

OP-62-350

1



ISLAND AREAS NOT SHOWN ON MAP

114	121
115	124
116	153
118	154
119	155
120	156
	157

CLIMATIC AREAS
OF THE WORLD

2

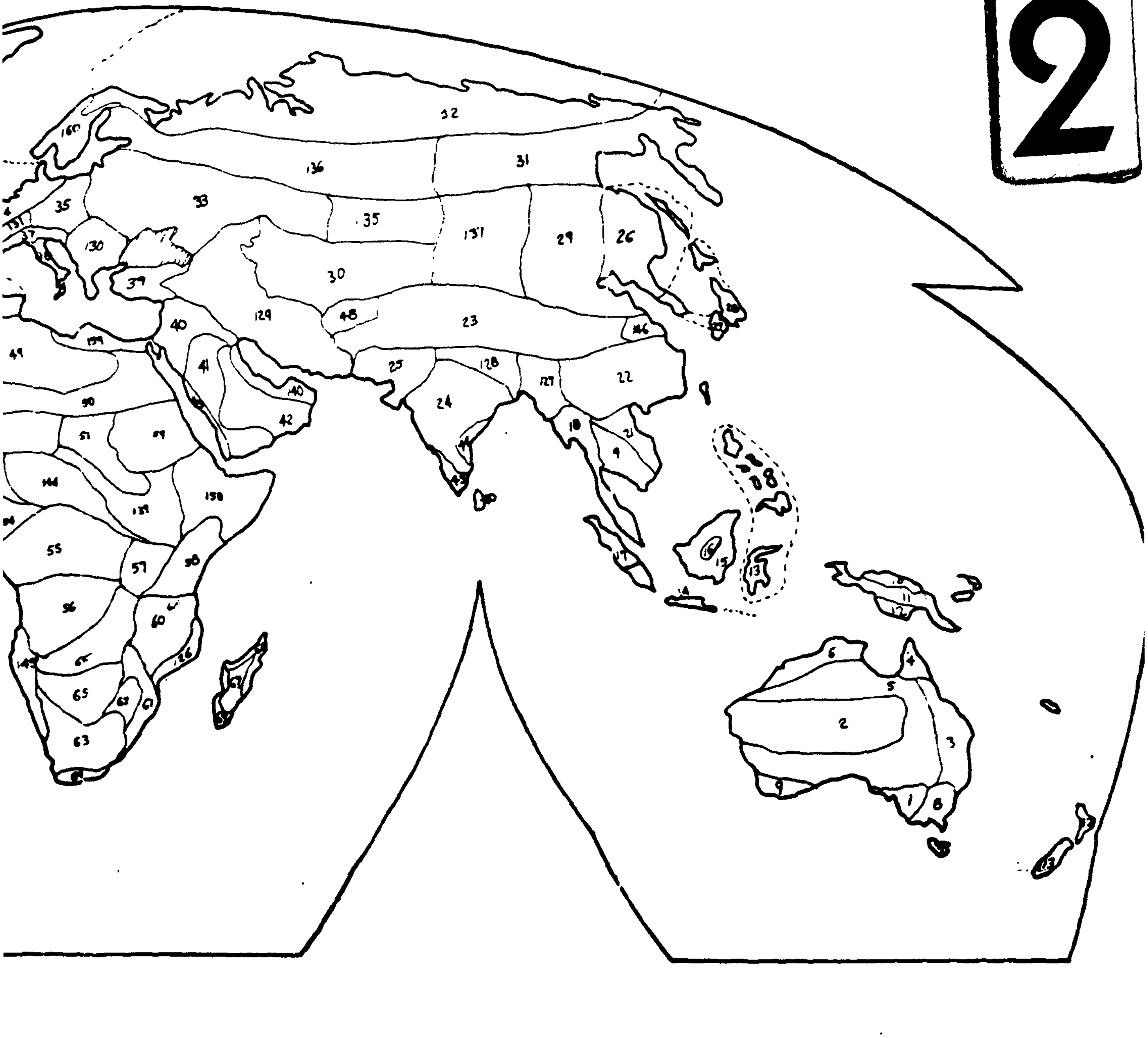


Figure 32

Climatic Area		Temperature	Rainfall	Vegetation	
Latin America	Pacific South America	Tropical & Sub-tropical	Tropical Wet to arid	Rain forest, Steppe and desert	Tropical c[illegible] normal [illegible]
	Atlantic South America (Mid)	Sub-tropical	Sub-humid to arid	Steppe and desert	Patagoni[illegible]
	Atlantic South America (Tropical)	Tropical	Tropical Wet	Rain forest	
	Meso America & Caribbean	Tropical	Sub-humid to arid	Savanna	Winter rai[illegible] a symmet[illegible]
Aus-tralia	Australia - New Zealand	Sub-tropical	Dry	Steppe and desert	Desert
Africa	Sahara, Sudan, & Guinea Coast	Tropical & Sub-tropical	Arid	Steppe and desert	Latitu[illegible]
	Congo Basin	Tropical	Tropical Wet	Rain forest	
	Tropical EastAfrica	Tropical	Dry to arid	Savanna	Extens[illegible]
	Southern Africa	Sub-tropical	Arid to humid	Desert & Savanna	Intens[illegible]
Asia	India	Sub-tropical to tropical	Sub-humid to tropical wet	Rain forest and savanna	Monsoo[illegible]
	S. E. Asia	Tropical	Tropical Wet	Rain forest	Winter
	Eastern Asia	Sub-tropical	Humid	Temperate forest	Bimoda[illegible]
Europe	Western & Central Europe	Sub-tropical	Humid	Temperate forest	Most m[illegible]
	Mediterranean	Sub-tropical	Dry	Temperate forest	Summer
North America	West	Sub-tropical to subarctic	Sub-humid to arid	Temperate forest and desert	
	Interior	Sub-tropical to subarctic	humid to sub-humid	Temperate forest and prairie	Low sn[illegible]
	South & East	Sub-tropical to subarctic	Humid to sub-humid	Temperate forest	Heavy

2

TABLE VI

DISTINGUISHING CLIMATIC FACTORS

Rainfall	Vegetation	Distinguishing Characteristics
'ropical Wet to arid	Rain forest, Steppe and desert	Tropical climates displaced northward, dryer than normal with very steep precipitation gradients.
Sub-humid to arid	Steppe and desert	Patagonia dryer than expected
'ropical Wet	Rain forest	None
ub-humid to arid	Savanna	Winter rainfall maximum less than expected; a symmetrical rainfall maximum.
Dry	Steppe and desert	Deserts aren't as dry as most deserts
Arid	Steppe and desert	Latitudinal breadth of dry areas
'ropical Wet	Rain forest	None
ry to arid	Savanna	Extensive rainfall anomalies
rid to humid	Desert & Savanna	Intense desert regions
ub-humid to ropical wet	Rain forest and savanna	Monsoon weather
'ropical Wet	Rain forest	Winter maximum rainfall in some areas
Humid	Temperate forest	Bimodal summer rainfall maximum
Humid	Temperate forest	Most maritime of all areas
Dry	Temperate forest	Summer-dry; great variations in rainfall
ub-humid to arid	Temperate forest and desert	None
humid to sub-humid	Temperate forest and prairie	Low snowfall, droughts
Humid to sub-humid	Temperate forest	Heavy rainfall in South

WORLD-WIDE
HIGH AMBIENT TEMPERATURE

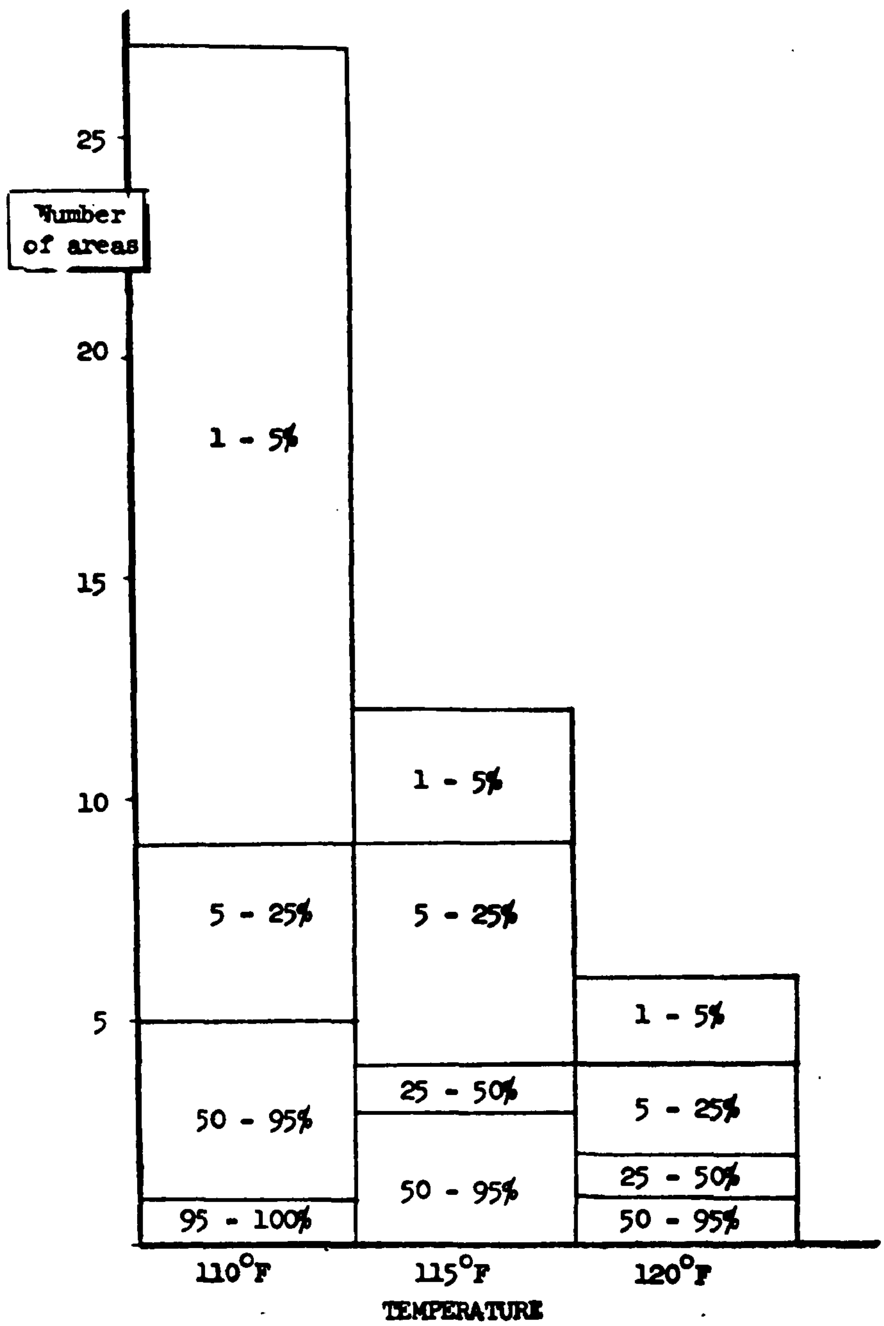


Figure 33

WORLD-WIDE
ANNUAL PRECIPITATION

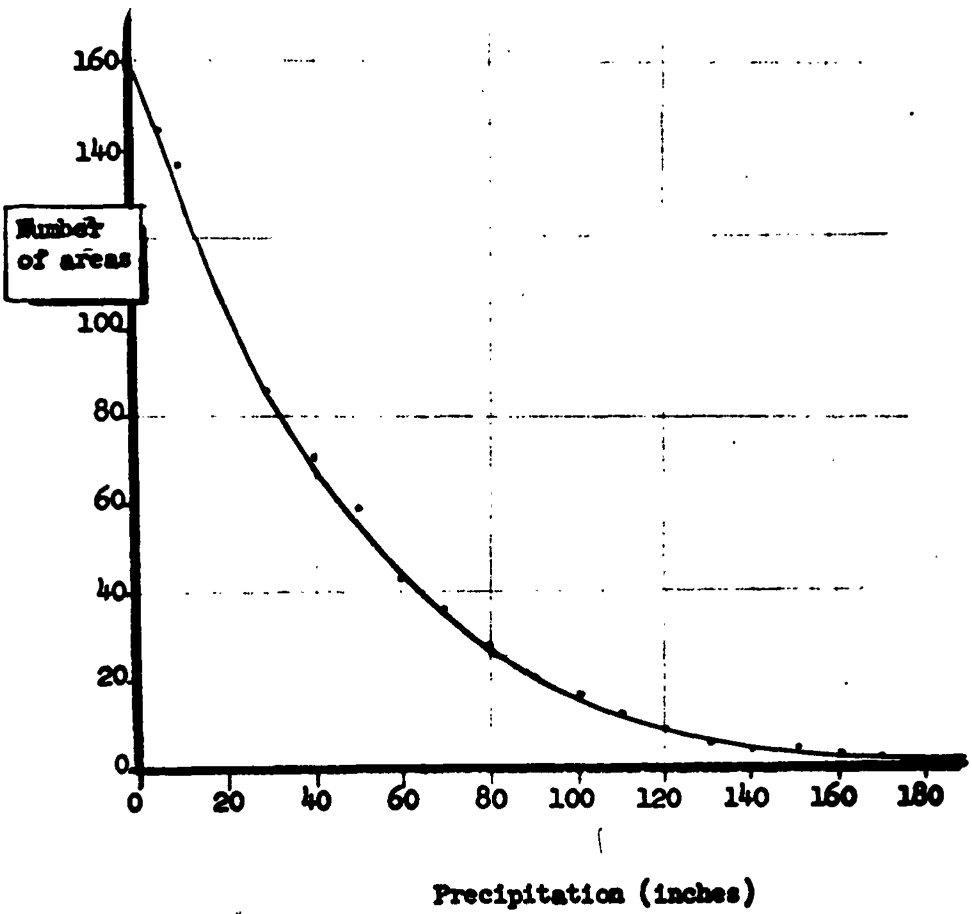
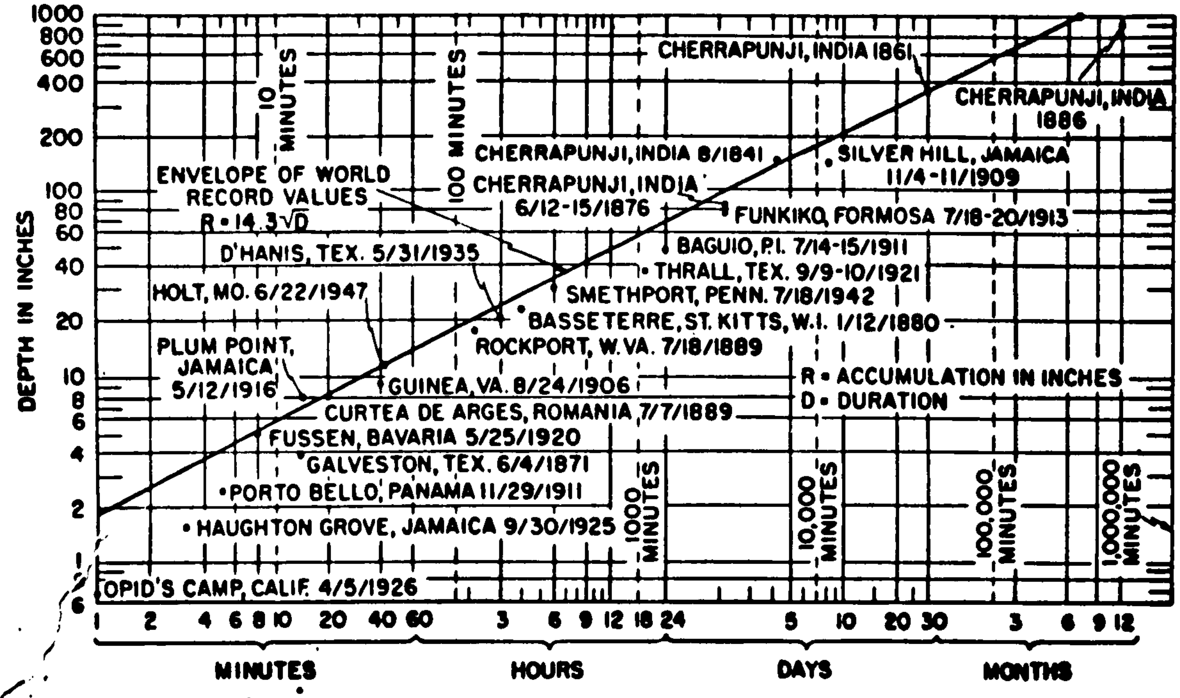


Figure 34



MAXIMUM RAINFALL FOR A GIVEN DURATION AT MAJOR WEATHER STATIONS

Instantaneous Rate* (in./hr)	Frequency (%)	Frequency (hrs/yr)	Probability of Occurrence
.06	2.16	189	1 in 46
.18	1.08	95	1 in 92
.40	.56	49	1 in 179
.80	.37	32	1 in 274
1.50	.21	18	1 in 487
3.00	.044	3.85	1 in 2,275
7.50	.0011	.096	1 in 91,250

INSTANTANEOUS RATE AT NEW ORLEANS

(Reference: Handbook at Geophysics for Air Force Designers)

Period (minutes)	Gulf Coast 5-Year Expectancy for a Point (in./hr)	World-Wide All Time Envelope for a Point (in./hr)
1	15*	112
5	7.2	48
10	6.0	36
30	4.5	22
60	3.0	15

HOURLY RATE ON GULF COAST

Figure 35

RELATIVE HUMIDITY
GLOBAL

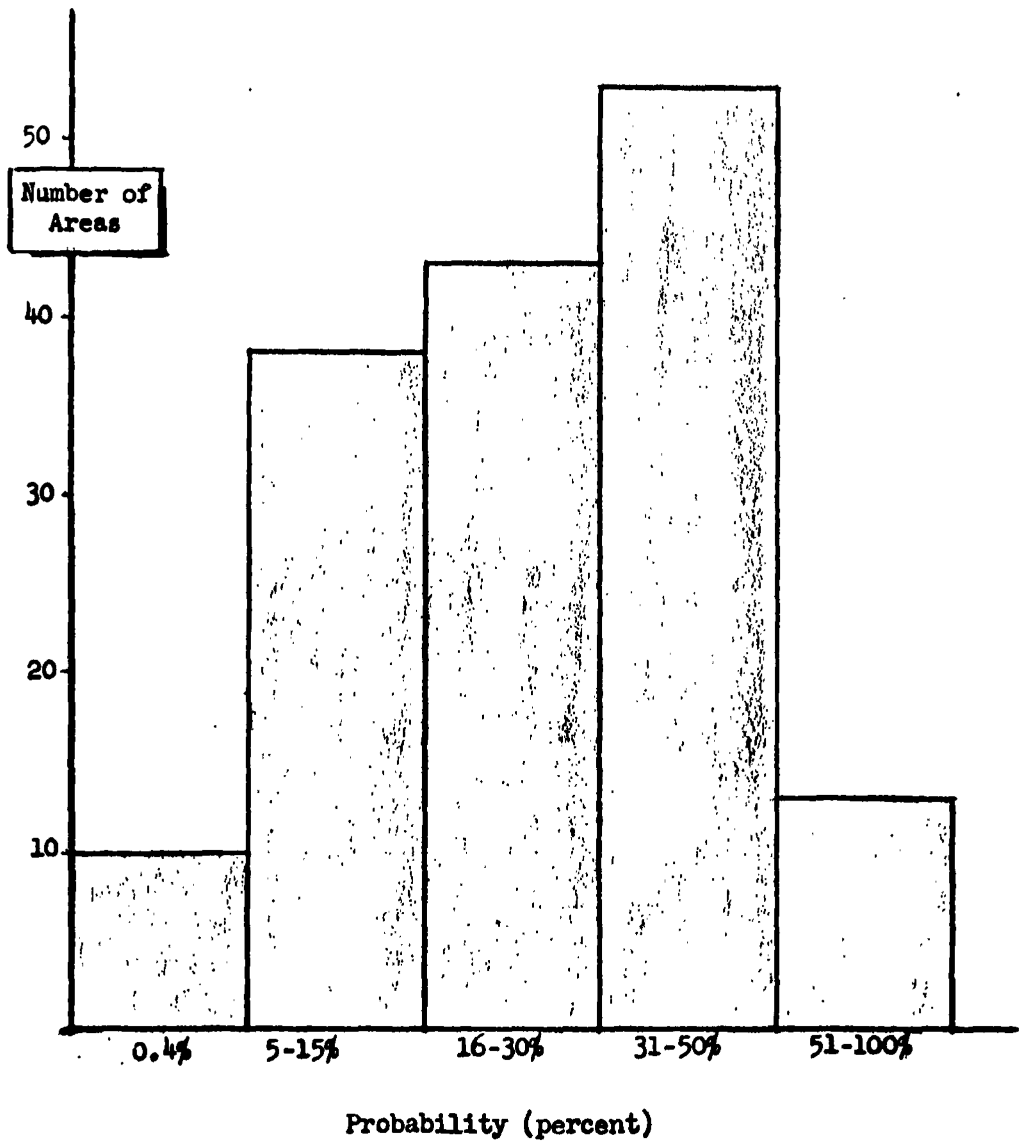
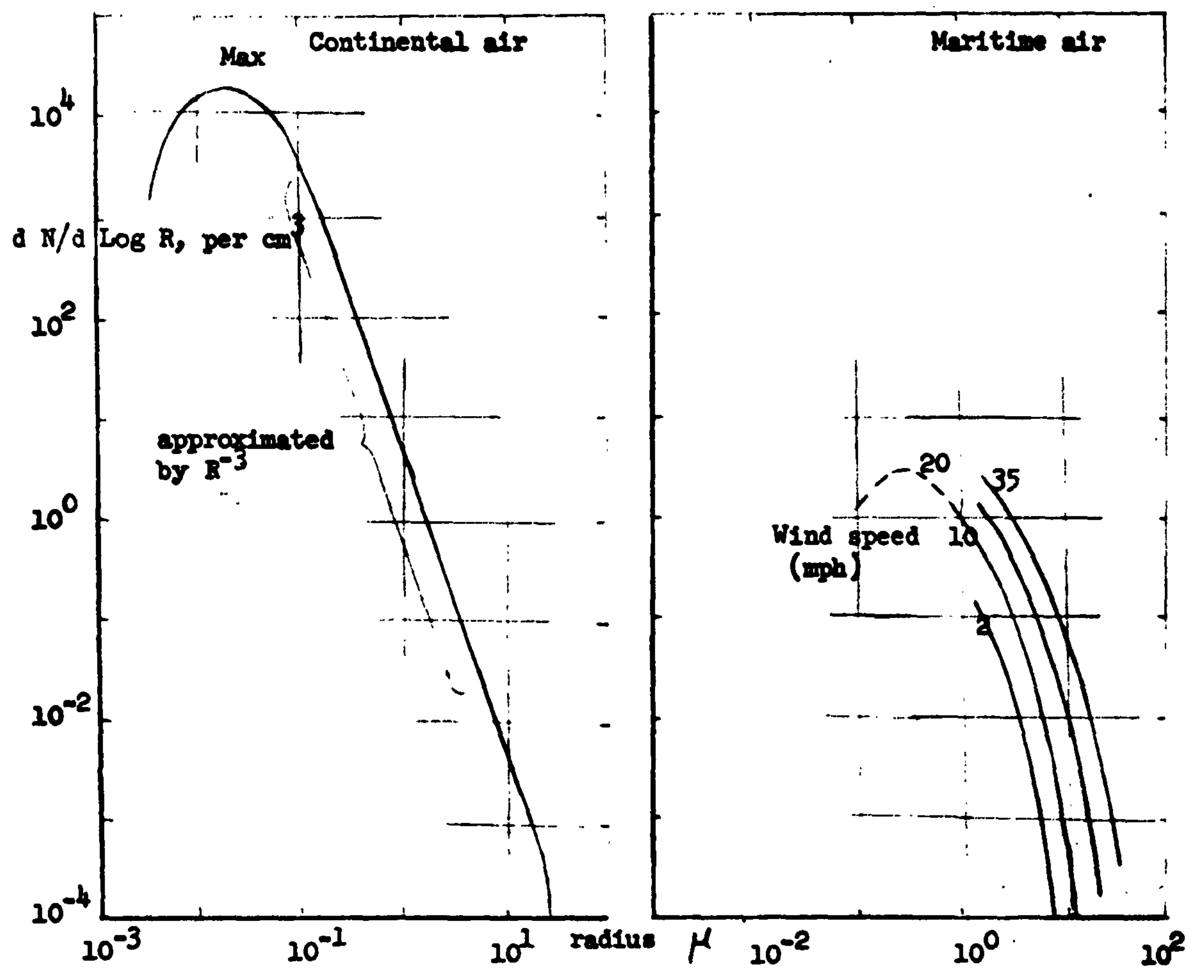


Figure 36

AEROSOL SIZE DISTRIBUTION



Increase in Aerosol Concentrations Due to Extreme Conditions

Condition	Multiplier	Size range
Smog in large cities	30	Whole size range
Dust clouds over deserts (excluding surface layer)	100	Particles > 0.1 μ
Surf areas along coasts	100	All sea spray particles
Storm areas over sea	10	Particles < 10 μ
	100	Particles > 10 μ

Figure 37

COMPARISON OF SAND AND DUST DIAMETERS

IN MIDWESTERN UNITED STATES

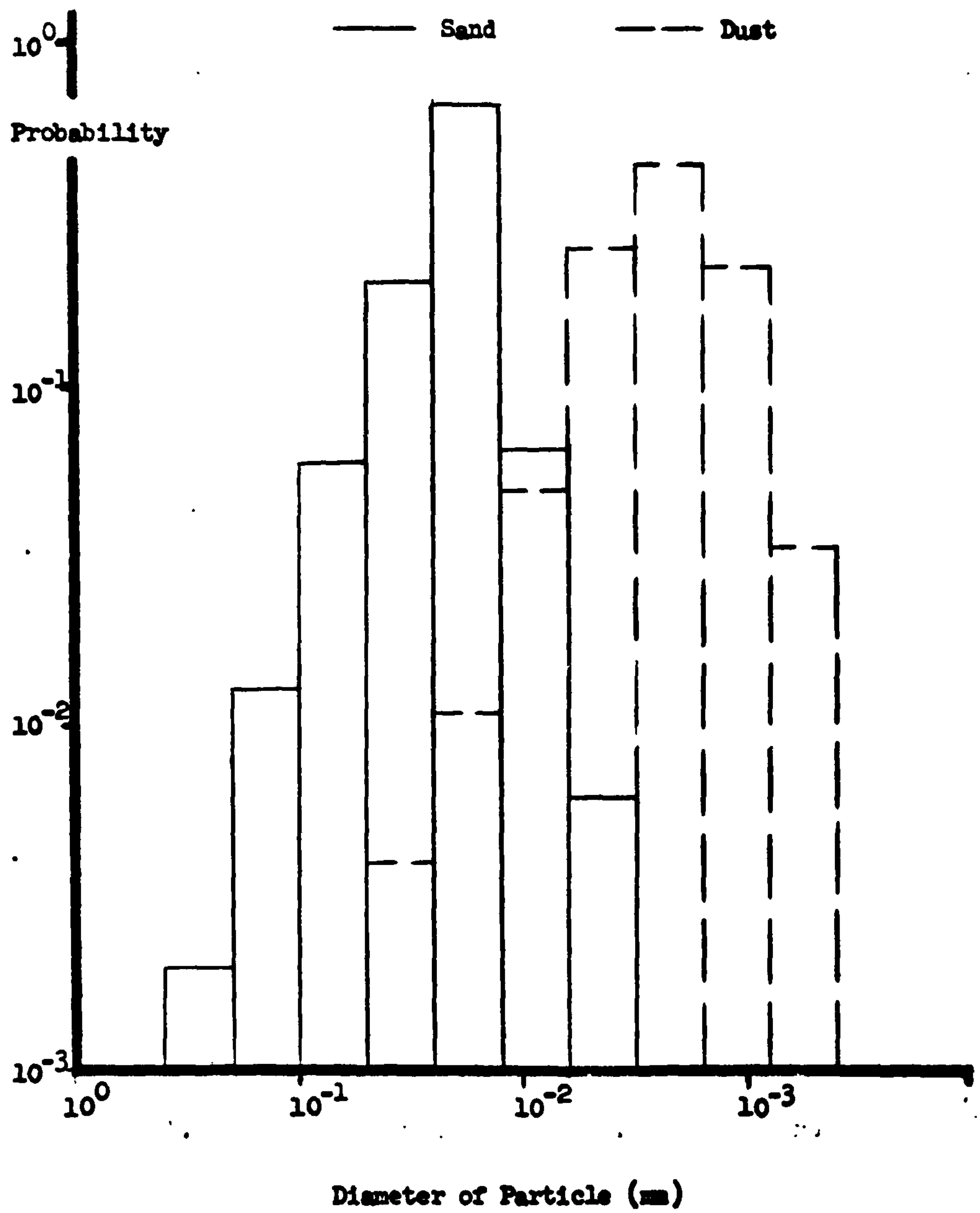


Figure 38

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(a) Jones, R.D., A Definition of Limited War Characteristics, NA61-688, North American Aviation, Inc., International Airport, Los Angeles 9, California, 18 July 1961.

(b) Red Timetable of World Conquest.

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(d) Jeppesen Airway Manual, Jeppesen and Company, Denver, Colorado, various dates.

(e) Airman's Guide, Federal Aviation Agency, Washington, D.C., 19 June 1962.

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(h) Pressman, Albert E., Richard L. Stitt, John H. Montanari, and Robert R. Blesch, Terrain Analysis of Ice-Free Land Sites in Arctic Canada, Aerosystems Engineering Division of Aeroservice Corp, Philadelphia, Pennsylvania, February 1961.

(i) Hartshorn, Joseph H., George E. Stoertz, Allen N. Kover, and Stanley N. Davis, Investigation of Ice-Free Sites for Aircraft Landing in East Greenland, 1959, Terrestrial Sciences Laboratory, Geophysics Research Directorate, Air Force Cambridge Research Laboratories, Office of Aerospace Research, United States Air Force, Bedford, Massachusetts, September 1961.

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(k) Environmental Analysis for System 482L/431L, Part I, Report 4387, USAF Climatic Center, Washington, D.C., October 1962

(l) Conference with Drs. Wessell & Bejuki, Prevention of Deterioration Center, National Academy of Sciences, 26 September 1962.

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1. Armed Conflicts
2. Airdromes and airbases
3. Climate

I System 482L
II Contract AF19(628)-1635
III North American Aviation Inc., Los Angeles Division, International Airport, Los Angeles 9, California
IV Laffoon, J. D., Walls, R. P., Whaley, C. F.
V NA-62-1284
VI In ASTIA Collection

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